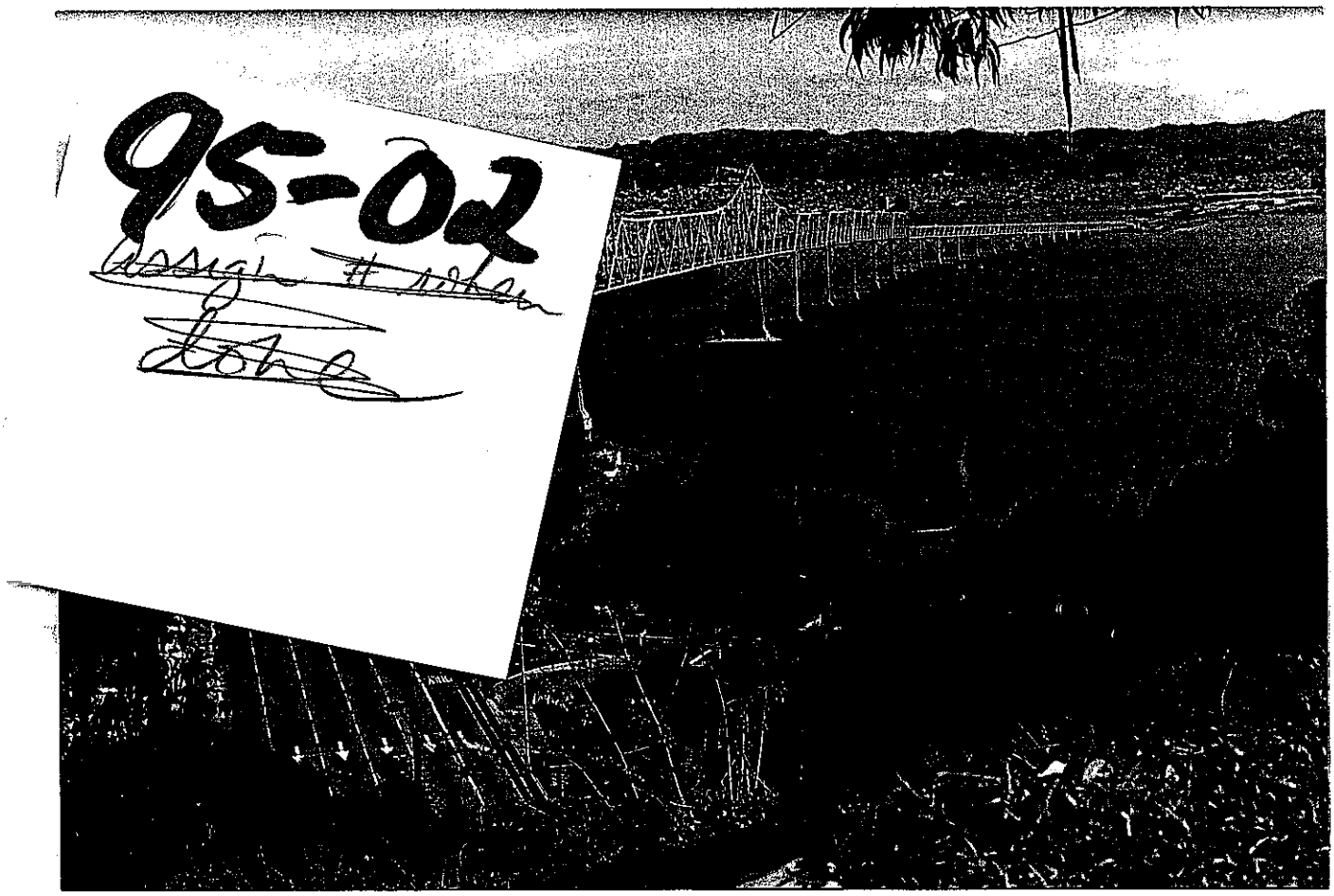
INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494



Report Written By
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Office of Structural Foundations
Engineering Service Center
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FOR THE EAST APPROACH STRUCTURE OF THE
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Introduction

This report presents the results of an indicator pile test program for Fundex piles which are under consideration for use in the seismic retrofit of the East Approach Structure to the San Francisco - Oakland Bay Bridge. Caltrans is currently planning to retrofit the San Francisco - Oakland Bay Bridge to withstand a maximum credible earthquake of magnitude 7.3 along the Hayward Fault. The retrofit will be such that there will not be any disruption of service after the event. The retrofit of the East Approach Structure will be the first of 19 projects.

The indicator pile program was initiated to anwer questions regarding pile wall thicknesses required for lateral loads, pile constructability, the need to fill the piles with concrete, and vertical tensile and compressive pile capacities. This indicator pile test program consisted of installing a total of sixteen Fundex piles and one driven pipe pile at three sites within the project area, see Appendix A - Location Map, documenting pile construction, conducting lateral and vertical pile load tests, and extracting one of the Fundex piles. In this program, all piles installed were the Tubex piles by the Fundex Corporation, but will be referred to as Fundex piles in this report.

This project consists of three sites containing five piles each, see Site Plan 1, 2 and 3 in Appendix A, with an extra Fundex pile and a driven pile installed at Site 1. Each site was chosen for its unique subsurface geology and are such that they represent subsurface conditions that will be encountered on the parent retrofit project, see the Soil Profile in Appendix A. The layout of the Fundex piles at each test site is the same and is shown in Appendix A - Load Test Pile Details. Piles 1 and 2 at each Site are 13 mm (1/2 in) wall thickness, and piles 3, 4, and 5 are 13 mm (1/2 in) and 19 mm (3/4 in) wall thickness, see Tables 3, 7 and 11 for Test Sites 1, 2 and 3, respectively. All wall thicknesses above elevation -7.6 m (-25 ft) will be increased on the parent retrofit project by 6.4 mm (1/4 in) over the tested thickness to compensate for corrosion. All Fundex piles were filled with concrete. At each test site, pile pairs 1-2 and 3-4 were subjected to lateral load testing by pulling these piles toward one another in the horizontal direction with a hydraulic jacking system. Pile 5 was subjected to axial compression and then tension load testing. All test piles were installed through casings extending to the bottom of any liquifiable deposits to simulate foundation performance during a seismic event.

Fundex Pile

The Fundex pile is a pipe pile with an drill point that is screwed into the ground by a track mounted drill rig, see Photograph Number 1 in Appendix B. The drill point is 660 mm (26 in) diameter, and the pipe piles are 510 mm (20 in) outside diameter, see Photograph Number 4 in Appendix B. As the pile is screwed into the ground, an annular space is formed between the pipe pile and the soil by the larger diameter drill point. Inside the pipe pile, there is a 38 mm (1.5 in) inside diameter grout pipe that delivers grout to holes in the drill point, see Photograph Number 5 in Appendix B. As the pile is screwed into the ground, new sections of pile and grout pipe are welded onto the previous section. A swivel connection at the top of the grout pipe allows grout to be pumped during pile installation. Since the Fundex pile is a displacement pile, there is some heave and grout at

the ground surface, see Photograph Number 2 and 9 in Appendix B. Noise and vibration levels are insignificant compared with driven piles and are on the order of noise and vibration levels experienced for cast in place piles.

Grout

The grout used in the installation of these piles is very fluid, and has a very high water/cement ratio of 0.97. The grout mixing plant consists of 2 positive displacement pumps, a holding tank, and a mixing tank. The holding tank also has mixing paddles that operate continuously while the grout is held, see Photograph Number 3 in Appendix B. A grout batch consists of five 418 N (94 lbs) sacks of Portland Cement Type II, 22.2 N (5 lbs) of Intraplast N, 296 mL (10 oz) of Plastiment, and 216 L (57 gal) of water. Both the Intraplast N, and the Plastiment are on the approved Caltrans product list. The Intraplast N is used as a fluidizer and an expansion agent. This is needed to counteract the considerable shrinkage produced by the extremely high water/cement ratio. The Intraplast N works by producing a gas which compensates for the shrinkage . The Plastiment is a grout retardent. The ingredients of this batch yield 303 L (80 gal) of grout, or 1.4 times the volume of the added water. This grout mix was used for Site 1 and 2 piles, but at Site 3, 1390 mL (47 oz) (296 mL per 445 N of cement (10 ounces per cwt. cement)) of Delvo was used instead of 296 mL (10 oz) of Plastiment per batch for the retardent.

According to Fundex representatives, Fundex piles are usually installed using water during drilling until the pile is within about a meter (few feet) of specified tip elevation. The advantage of this is that the pile can penetrate at a faster rate, and it allows the pile to penetrate otherwise impenetrable dense sands. The water allows the pile to penetrate dense sand by transporting it to the surface. Another advantage is that a pile can be partially installed and then completed at a later time. At production rates observed for this project, this would make it possible to install one and one-half piles in one shift. A pile that is grouted full length must be completed once started regardless of what time drilling began. This method of installation also provides some flexibility in the event of a mechanical break-down of pile driving and grouting equipment.

Initially, Caltrans designers required the contractor to grout during drilling the piles on this project in order to assure that the cavity between the soil and the pile wall was filled. To accommodate this need, the contractor added retardent to the grout mix. It was subsequently discovered, however, that this left open the possibility that grout could set prematurely if the temperature of the grout should increase. The increase in temperature is caused by friction as the pile tip encounters dense sand. However, after no pile at Site 1 was able to penetrate to specified tip elevation, piles 3, 4 and 5 at both Site 2 and 3 were installed using so-called "post" grouting techniques. Piles 1 and 2 were installed by grouting the entire length during drilling. As used here, Post grouting is grouting that is initiated within 3 m (10 ft) of specified tip elevation and halted less than a meter (a foot or two) above specified tip elevation. "Post" grouting uses a volume of grout that theoretically would fill the annular space around the pile. The disadvantage of the "post" grouting technique is that there is a greater probability that the grout around the pile is

inconsistent in thickness. It seems more probable in the "post" grouting technique that grout could be thin or non-existent in certain parts.

Low Overhead Clearance

Certain operations were performed on this project to simulate low overhead clearance. The Fundex drilling rig itself was not brought to the site in a low overhead configuration. The rig has a 12+ m (40+ foot) crane mast that is removable, but it was not removed. The crane mast was not used during pile installation except as added weight for crowd pressure, see Photograph Number 1 in Appendix B. The rig also has hydraulic rams to operate the drilling table that stand 5.8 m (19 ft). The low overhead condition that was simulated was 4.9 m (16 ft), which is the minimum clearance at some locations in the retrofit project. The contractor did not deem it feasible to fabricate new rams that would allow the Fundex rig to operate within a 4.9 m (16 ft) vertical clearance just for this indicator pile test program. Pipe pile segments were limited to 3.7 m (12 ft) because this was the maximum length which the contractor indicated could be installed by this rig with a 4.9 m (16 ft) vertical clearance. The only pile segments that were greater than 3.7 m (12 ft) were the first sections. The length of these sections was determined by adding the length of the casing, a 0.9 m (3 ft) stick-up from the ground surface to the jaws of the Fundex rig, and 3.7 m (12 ft) of penetration into the soil below the bottom of the casing. Later in the project the contractor was required to prove that at least a 3.7 m (12 ft) section of pile could be spliced under a 4.9 m (16 ft) vertical clearance. This test showed that the longest pile segment that could be installed under a 4.9 m (16 ft) vertical clearance was 2.7 m (9 ft). Splice segments were not altered after this new information was gathered, however, plots of penetration versus time were modified by adding a "projected installation time" line that was developed by considering a 2.7 m (9 ft) splice length, typical penetration rates and the average splice time of 90 minutes.

Subsurface Conditions

The San Francisco - Oakland Bay Bridge East Approach is constructed on a narrow fill section commonly referred to as the mole section. The approach consists of 17 bents and is approximately 335 m (1100 ft) long. A generalized Soil Profile is shown at the end of Appendix A. Surface elevations range from approximately +2.5 to +4 m (+8 ft to +14 ft) M.L.L.W. Ground water levels fluctuate with the tide, which ranges from +0 to +1.7 m (+0.0 to +5.6 ft) M.L.L.W. Surficial soils consist of 6 to 9 m (20 to 30 ft) of fill material. The fill consists of loose silty sand, gravel, and cobbles. Typical corrected blow counts in the bottom 3 m (10 ft) of the fill range from 7 to 20 while in the upper fill range from 15 to 30. Underlying the fill is a layer of young Bay Mud. Bay Mud is a moderately sensitive silty clay, with a uniform soil classification system (USCS) designation CH-MH. As shown in the Soil Profile at the end of Appendix A, the Bay Mud layer is 6 m (20 ft) thick beneath load test site 1 increasing to 15 m (50 ft) thick beneath load test site 3. Underlying the Bay Mud at load test sites 1 and 2 is a 6 m (20 ft) thick layer of dense sand followed by deep deposits of old bay clay. At Site 3 the Bay Mud is underlain by old bay clay. Depth to bedrock is approximately 143 m (470 ft).

Lateral Load Test Procedures

Lateral load tests were performed on twelve grouted Fundex piles constructed with 510 mm (20 in) diameter steel pipe piles with 13 mm (0.5 in) and 19 mm (0.75 in) wall thicknesses. Lateral pile load tests were accomplished in pairs by jacking two piles together with one set of high strength thread bars connected to the piles and two hydraulic jacks connected in series. A schematic diagram including plan and profile views of a typical lateral load test layout is presented in Appendix B "Project Photographs and Diagrams".

Piles were tested in general accordance with ASTM D 3966-81 entitled "Standard Method of Testing Piles under Lateral Loads." The loading procedure generally conforms to Section 6.4.2 entitled "Surge Loading with Standard Loading" where standard loading durations of 20 to 30 minutes were used. Nominal load increments equal to 22 to 44 kN (5 to 10 kips) were applied to each test pile and held for a period of 20 to 30 minutes. While the load increment was held, slope inclinometer readings were performed to measure horizontal pile deflections at various depths. In general, ten load cycles were applied to each pile with applied loads removed at the maximum load attained during the first load cycle. A load cycle is defined as the period during which the applied load is increased to some maximum value and then decreased to zero. A plot of applied lateral load versus elapsed time for each test pile is presented in Appendix E and F for Site 1, Appendix G and H for Site 2, and Appendix I and J for Site 3. These plots illustrate the load-time history of each test pile and therefore graphically describe the test procedures used for all the piles at each test site.

Each time the test load was held, slope inclinometer readings were typically taken in each pile in order to measure horizontal deflection along the pile length. All slope inclinometer readings were recorded by hand at the time the test was performed. Checksum values were calculated and checked prior to the continuation of testing. Load applied to each pile was measured with one electronic load cell mounted on either the pile head assembly or at the end of the jacks. Horizontal displacements of the pile head were measured using a total of two displacement transducers mounted about 0.6 m (2 ft) behind each pile and typically less than 25 mm (1 in) below the top of the pile. These transducers were mounted on steel arms welded to a segment of 510 mm (20 in) diameter steel pipe pile such that each pot was independently referenced, see Photograph No. 11 and 12 in Appendix B.

Load Displacement Measurements at the Pile Top

A general assessment of the lateral load behavior at the top of a pile embedded in a given soil profile can be made by examining the relationship of lateral load versus horizontal displacement. Piles tested for this project were cased over the upper 6.1 to 8.5 m (20 to 28 ft), and the load displacement relationships reflect the behavior of a free standing column rigidly connected to a pile embedded in soil. In addition, the lateral load versus horizontal displacement graphs may be influenced by the unknown volume of grout around the pile below the base of the steel casing or within the steel casing below the mud line. The mud line was frequently measured at an elevation above the base of the steel casing. In an attempt to minimize these affects, the mud and grout within each casing after

pile installation was removed by augering. Observations made while augering indicated that typically the grout was 0.6 m (2 ft) thick within the casing and that mud heaved into the bottom 1 m (3 ft) of the casing. A plot of lateral load versus horizontal displacement for each pile is presented in the Appendices for the appropriate site and pile number.

Slope Inclinometer Measurements

Slope inclinometer measurements were recorded at selected lateral load increments and provide useful information about the variation of horizontal displacements of the pile with depth. This information provides an indication of the degree of pile bending with depth and can be used to refine lateral pile design. A summary of slope inclinometer reading events with corresponding cycle number, average measured lateral load, measured horizontal deflection near the pile top, and statistical parameters for each test pile is presented in the Appendices.

The slope inclinometer instrument measures slope changes inside an ABS plastic casing cast within concrete in each test pile. Slope changes are measured in two directions orthogonal to each other. One direction is in line with the application of lateral load and is referred to as the "A-direction". A second direction is transverse to the direction of applied lateral load and is referred to as the "B-direction". The accuracy of slope measurements in the A-direction is generally much greater than slope measurements in the B-direction. This is due to the fact that although there are 4 grooves on the inside of the slope inclinometer casing, there are only 2 sets of wheels and springs set in those grooves to align the probe. Therefore, when the probe is removed from the casing and rotated 180 degrees, the wheels and the pressure of the springs act to position the probe in the same relative position. In the B-direction, however, there is nothing aligning the probe in the grooves to ensure that there is a constant distance between the probe and the slope inclinometer casing.

Horizontal displacements can be calculated from the measured slope over the length of the slope inclinometer instrument. If the base of the slope inclinometer casing is assumed fixed, displacements can be summed up over the length of the casing starting at the base and proceeding to the top. Therefore, instrument errors tend to accumulate from the bottom to the top. In general, the accuracy of measured horizontal displacements is within about 6.4 mm over 30 m (1/4 in over 100 ft) of casing, assuming no operational errors such as positioning the wheels of the instrument between two segments of casing. Measured slope inclinometer deflections in the A-direction are in very good agreement with displacements measured close to the pile top by highly accurate transducer pots. Calculations indicate that for a typical lateral deflection of 510 mm (20 in), the error associated with the slight downward movement of the pile head (about 13 mm (0.5 in)) is on the order of less than 0.127 mm (0.005 in). Therefore, it seems reasonable to assume that corrections for casing twists (discussed later in this report), slight downward inclinations of wire lines extending from transducers, and instrument errors are likely not needed. Further, an accurate determination of lateral deflections at any depth along the test piles can be made. It should be noted that measured deflections in the B-direction were generally in poor agreement with independently measured transverse displacements about 1 foot above the top of the piles. Profiles of horizontal displacement measurements in the

direction of the applied lateral load (A-direction) and pile elevation are presented the Appendices, as are the displacements transverse to the applied lateral load (B-direction).

As mentioned previously, statistical parameters were calculated for each slope inclinometer reading event and presented in the appropriate Appendix E through J. Readings were taken in the 0 and 180 degree positions in accordance with standard operating procedures and mean values of the checksum (MCS) for each deflection profile were calculated. In general, the absolute value of the mean checksum should be less than 50 for a properly functioning inclinometer instrument. The standard deviation of the checksum values (SDC) was determined. The standard deviation of checksum values for each load increment should remain somewhat constant throughout the entire pile load test. The absolute value of the difference between the standard deviation of the baseline checksum and each subsequent lateral load checksum (SDD) were calculated. SDD values should be less than 3 to 5 for highly accurate slope inclinometer surveys. Finally, the difference between the maximum checksum value and the mean checksum (MCV) for a given slope inclinometer reading event was determined. MCV values should be less than 10 and 20 for the A and B directions, respectively. In general, all statistical parameters calculated for each load increment of each test pile indicate values within these suggested guidelines. In a few cases the MCV value consistently exceeded 10 and 20 for the A and B directions, respectively, and in all cases the resulting survey indicated a consistently high checksum value at a particular depth within the slope inclinometer casing but accurate displacement measurements at the top of the pile. For these cases, it is possible that the high localized checksum error occurred at the location of a casing joint, a casing region with sharp curvature, or a casing section that was out of round.

Slope Inclinometer Casing Rotation Measurements

In order to determine the orientation of the slope inclinometer casing grooves over the length of the casing, a spiral sensor instrument was used to measure incremental casing twists. Data collected from the spiral sensor can be used to resolve the A-direction and B-direction components of the slope inclinometer readings into the direction of the applied lateral load.

The orientation of the slope inclinometer casing grooves was determined for each test pile by first measuring the bearing of the A-direction grooves at the top of the pile with respect to the direction of the applied lateral load. Spiral sensor measurements were then averaged and converted to values of rotation of the A-direction casing groove with respect to the direction of the applied lateral load. A complete rotation or twist profile for each slope inclinometer casing was developed starting with the measured bearing at the top of the test pile and adding the measured casing rotation determined by the spiral sensor measurements. Slope inclinometer casing rotation profiles are presented graphically for each test pile and test Site in the Appendices. The reported accuracy of each spiral sensor reading is about plus or minus 10 minutes over the length of the instrument or 1.5 m (5 ft) of casing. In general, all measured casing rotations are within about plus or minus 5 to 6 degrees for lateral pile deflections less than about 25 mm (1 in). Based on the general lack of accuracy exhibited by the B-direction slope inclinometer readings and the relatively

small twists measured in the slope inclinometer casings, corrections based on the resolution of the A and B directions would result in unsatisfactory errors.

Axial Load Test Procedures

All compression and tension static pile load tests were performed in general accordance with ASTM D 1143-81, Section 5.6 and ASTM D 3689-90, Section 7.7, respectively, entitled "Quick Load Test Method for Individual Piles". In general, 178 kN (40 kip) load increments (compression) and 89 kN (20 kip) load increments (tension) were applied to each test pile and held for a period of five minutes. During unload or reload cycles, each load is held for a period of one minute. Any variations to these general procedures are identified below at each test site location, see Photograph Number 6 in Appendix B.

Site 1

Pile Installation

Site 1 (Pile 2) is located 14 m (45 ft) north of Station 276+13, center line of the upper deck of the I-80 San Francisco - Oakland Bay Bridge, see Site Plan 1 in Appendix A. This is directly north of Bent E26A. All piles except the sample pile and the driven pile were installed through a 1.52 m (60 in) diameter casing that was installed from the ground surface elevation of 3 m (10 ft) to elevation -3 m (-10 ft) (6.1 m (20 ft) in length). The casing was installed by drilling a 1.5 m (5 ft) deep hole with a 1.5 m (5 ft) diameter auger. The casing was then stabbed and vibrated to the required tip elevation. The casing was then drilled out to within a couple feet of the tip with a conventional auger, and finished with a 1.5 m (5 ft) diameter clean out bucket.

Added Pile (Sample Pile)

This pile was added to this program to assess the grout retardent and assess the effects of the grout on pile installation. The pipe pile used had a 510 mm diameter and a 13 mm wall thickness (PP20" x 0.5") and was 13.1 m (43 ft) in length. This pile was installed 6.1 m (20 ft) east of the 5 pile group at Site 1, see Photograph Number 2 and 9 in Appendix B. This location was chosen because the area had been previously cleared for underground utilities. The method of installation was as follows: the pile was started from the ground surface and installed to a penetration of 3.0 m (10 ft) while grouting continually. Installation was then suspended for 1 hour to simulate the time required for a splice (during installation of the test piles it was discovered that the average splice time was 90 minutes, not 60 minutes). The pile was then installed to 6.1 m (20 ft) with an hour hold, and then to 9.1 m (30 ft) with an hour hold. The pile was then installed to 12.2 m (40 ft) with a 1.5 hour hold. After this hold, the pile was turned by the table and grout was pumped. During the grouting with the pile at penetration 12.2 m (40 ft), grout was observed coming up at the ground surface in the annular space caused by the oversized tip, see Photograph Number 9, Appendix B.

From all indications, when the pile is grouted during installation, there does not appear to be significant mixing of the grout and the Bay Mud. However, this may not be true for grout mixing in the sand layers.

Difficulties encountered installing this pile include maintaining plumb, and removal of the grout line caused the inside of the pile to fill with 1.8 m (6 ft) of grout. Also after every hold when grout pumping was resumed, grout was observed pouring out at the ground surface immediately adjacent the pile. The ground around the pile was covered with 100 mm (4 in) of grout, and the soil heaved about 300 mm (1 ft). No lateral or vertical load tests were performed on the sample pile.

Efflux measurements were taken on the grout every hour for the first 5 hours. These readings started at 9 seconds and were 10 seconds after 5 hours. For reference, water has an efflux time of 8 seconds. 50.8 mm by 101.6 mm (2 in by 4 in) cylinders were taken of the grout from the second batch. Testing performed on these grout samples showed that the grout had an average compressive strength of 3.72 MPa (540 psi) after 14 days. The samples were observed to be stratified, with weaker layers near the top of the sample. The compressive strength referred to above is based on the testing of complete cylinders with weak layers included. Other samples were taken to measure the strength of the bond between the outside of the pile and the grout. The average bond strength after 14 days was 2.14 MPa (310 psi).

See Table 1 "Site 1 Installation Information" below, and "Fundex Pile Installation Records" in Appendix C. Also, at the beginning of this Appendix is the "Fundex Drill Table Torque Graph", which shows the relationship between the bar readings shown in the installation records and the actual torque.

Table 1 - Site 1 Installation Information

	Date Installed	Date Tested	Specified/ Actual Tip El. m (ft)	Installation Time (hours)	Projected Installation Time (hours)
Pile 1	11/16/94	12/2/94	-12.2/-11.4 (-40/-37.5)	5.6[a]	5.0[b]
Pile 2	11/17/94	12/2/94	-12.2/-11.9 (-40/-39.0)	5.6[a]	5.0[b]
Pile 3	11/21/94	12/7/94	-12.2/-11.1 (-40/-36.5)	4.5[a]	5.0[b]
Pile 4	11/21/94	12/7/94	-12.2/-10.7 (-40/-35.2)	5.3[a]	5.0[b]
Pile 5	11/18/94	Comp. 12/9/94 Tension 12/12/94	-12.2/-10.7 (-40/-35.2)	5.6[a]	5.0[b]
Pile 6 (Driven Pile)	12/22/94	Tension 12/28/94	-12.2/-12.2 (-40/-40.0)	0.4[c]	N/A
Added Pile (Sample Pile)	11/14/94	Not Tested	-9.1/-9.1 (-30/-30.0)	6.2[c,d]	N/A

a This installation time is based on 3.7 m (12 ft) sections. Note that all Fundex piles at this Site failed to achieve specified tip elevation. All piles at this Site were grouted during drilling.

b The projected installation time is based on 2.7 m (9 ft) sections, and that specified tip elevation was reached by using post grouting techniques, instead of grouting during drilling.

c This pile was installed full length without any splices.

d Installation time for this pile includes simulated splice times.

Pile 1 at Site 1 was the first test pile installed. The ground surface elevation was 3.0 m (10 ft), the specified tip elevation was -12.2 m (-40 ft), and the piles were installed in a 6.1 m (20 ft) long casing . This pile was installed on November 16, 1994. This pile was 15.4 m (50.5 ft) in length with a wall thickness of 12.7 m (1/2 in), and the total installation time was 5 hours and 38 minutes.

The spliced lengths for all piles at this site were 10.1, 3.7 and 2.4 m (33, 12 and 8 ft), with the excess length cut off to give a stick-up of 0.9 m (3 ft) above the ground surface. At a depth of 14.5 m (47.5 ft), penetration 8.4 m (27.5 ft) and 0.8 m (2.5 ft) above specified tip elevation, the Fundex machine was unable to turn the pile with the maximum torque applied.

A possible explanation for this was that although the grout was retarded, higher temperatures caused by friction between the pile tip and the sand caused the grout to prematurely set in this region.

For pile 2 the Fundex Company recommended that more grout be used to transport the sand to the surface and to prevent the pile from freezing up. This pile was installed similarly to pile 1 until the dense sand was reached. Then grout was pumped at a higher rate than pile 1. The result of this was that the pile could not be held in place horizontally and the pile wandered 250 mm (10 in) from its intended location. The pile did, however, penetrate 0.5 m (1.5 ft) further to 0.3 m (1 ft) above specified tip elevation. Pile 2 was made of 15.8 m (52 ft) of 12.7 mm (1/2 in) wall pipe. This pile was installed on November 17, in 5 hours and 36 minutes.

Table 2 - Site 1 Installation Details

	Grout Batches Used[a]	Depth to Mud from Top of Casing Before Pile Installation[b] m (ft)	Depth to Mud from Top of Casing After Pile Installation m (ft)	Depth to Mud from Top of Casing Before Testing[c] m (ft)
Pile 1	4	5.2 (17.0)	4.6 (15.1)	5.5 (18.2)
Pile 2	9	5.2 (17.0)	3.1 (10.1)	3.4 (11.3)
Pile 3	3	4.9 (16.0)	4.7 (15.3)	4.7 (15.5)
Pile 4	4	5.5 (17.9)	4.8 (15.7)	5.0 (16.5)
Pile 5	3	5.5 (18)	4.5 (14.9)	4.9 (16.2)
Pile 6	N/A	N/A	N/A	N/A
Added Pile	7	N/A	N/A	N/A

a A grout batch equals 300 L (80 gal) of grout or 0.3 m^3 (10.7 ft^3)
b Drilled to bottom of casing depth of 6.1 m (20 ft) before pile installation.
c The annular space between the pile and the casing was cored and augered with a drill rig to a depth of 6.1 m (20 ft) after pile installation and before any testing.

Pile 5 was the next pile installed with no significant difficulties except that the pile stopped 1.5 m (4.8 ft) above specified tip elevation. This pile was installed on November 18, in 5 hours and 35 minutes. Piles 3, 4 and 5 were made of 8.5 m of 12.7 mm (28 ft of 1/2 in) wall thickness pipe in the lower portion of the pile, and then 6.6, 6.2 and 6.2 m (21.5, 20.2 and 20.2 ft) of 19 mm (3/4 in) wall thickness pipe in the upper portion of piles 3, 4 and 5, respectively. All piles at this site were installed by grouting during installation.

Piles 3 and 4 were both installed on November 21, and stopped 1.1 and 1.5 m (3.5 and 4.8 ft) above specified tip elevation, respectively. The first section of piles 3, 4, and 5 were made up of 8.5 m of 12.7 mm (28 ft of 1/2 in) wall thickness pile and 1.5 m of 19 mm (5 ft of 3/4 in) wall thickness pile.

At the conclusion of pile installation, the area between the casing and the pile was drilled out. Table 2 - Site 1 - Pile Installation Details shows the soundings that were performed before and after pile installation and before testing. After the casings were vibrated to

depth, they were drilled out completely to the bottom of the casing as determined by soundings since the casing was filled with water. However, after settlement of solids suspended by the stirring action of the auger, all of the casings had between 0.6 and 1.2 m (2 to 4 ft) of mud in the bottom. This material was not removed prior to pile installation since the pile installation would cause pile heave and there would also be grout that would have to be removed. It was decided to remove all of this material at one time after installation.

After pile installation (as stated in Table 2) the total amount of material in the bottom of the casings consisted of sediment from casing installation, heave and grout from pile installation and amounted to as much as 3 m (10 ft). It is estimated that Pile 2, for example, had more than 1.5 m (5 ft) of grout alone. Soundings performed a day after installation showed that the very top layer of material in the casing was hard grout.

Drilling between the piles and the casings required three days and several different types and size drill bits. The types of drill bits used were core barrels and spin augers. Soundings were performed during drilling and confirmed that this area was cleaned out, see Photograph No. 10 in Appendix B. However, soundings taken just before testing showed that again there was a substantial amount of material in this area. It is unclear how much of this material is from settlement from the drilling operation, or how much, if any, was from heaving of material into the casing.

All Site 1 piles were poured on November 23, 1994. Concrete strengths were determined by 7, 9 and 14 day breaks with two 152 mm by 305 mm (6 in by 12 in) cylinders for each break. The average concrete strengths for the 7, 9 and 14 day breaks were 20.9, 25.2 and 29.6 MPa (3030, 3660 and 4290 psi).

Driven Pile

A driven pile was added to the program to assess constructability of driven piles in the dense sand material encountered at Site 1 from elevation -9.1 m to -12.2 m (-30 ft to -40 ft). The pile used was a 610 mm (24 in) diameter open ended steel pipe pile (PP24 x 0.75), 18.3 m (60 ft) in length with a wall thickness of 19 mm (3/4 in). It was driven open end with a Vulcan 80C double acting air hammer on December 15, 1994. The Vulcan 80C has a rated energy of 33.2 kJ (24.5 kip-ft), with a ram weight of 35.6 kN (8 kips). The capblock weighed 8140 N (1830 lbs) and contained six 25.4 mm (1 in) plates of Micarta, and five 12.7 mm (1/2 in) plates of Aluminum. The pile was predrilled from the ground surface elevation of 3 m (10 ft) to elevation -1.5 m (-5 ft), with a 610 mm (24 in) diameter auger. The pile was monitored during driving with a Pile Driving Analyzer (PDA) and plotted results are included in Appendix K. The soil within the pile was 1.5 m (5 ft) down from the ground surface elevation at the completion of driving, which means that a pile plug did not form. Although the pile was predrilled 4.5 m (15 ft), material did slough into the hole during the "stabbing" operation.

Table 3 - Site 1 Pile Wall Thickness

	12.7 mm (1/2 in) Wall Thickness From El. To El. m to m (ft to ft)	19 mm (3/4 in) Wall Thickness From El. To El. m to m (ft to ft)	Length of 12.7 mm (1/2 in) Wall Thickness m (ft)	Length of 19 mm (3/4 in) Wall Thickness m (ft)
Pile 1	-11.4 to 4.0 (-37.5 to +13)		15.4[a] (50.5)	
Pile 2	-11.9 to 4.0 (-39 to +13)		15.8 (52)	
Pile 3	-11.1 to -2.6 (-36.5 to -8.5)	-2.6 to 4.0 (-8.5 to +13)	8.5 (28)	6.6[a] (21.5)
Pile 4	-10.7 to -2.2 (-35.2 to -7.2)	-2.2 to 4.0 (-7.2 to +13)	8.5 (28)	6.2[a] (20.2)
Pile 5	-10.7 to -2.2 (-35.2 to -7.2)	-2.2 to 4.0 (-7.2 to +13)	8.5 (28)	6.2[a] (20.2)
Pile 6		-12.2 to 4.0 (-40 to +13)		16.2[a] (53)
Added Pile	-9.1 to 4.0 (-30 to +13)		13.1[a] (43)	

a This length includes a pile stick-up above the ground surface of approximately 0.9 m (3 ft)

Lateral Load Testing

The first lateral load test at this Site tested piles 1 and 2. During the reading of the slope inclinometers during the zero load starting point, it was realized that the amount of time estimated for these readings was severely underestimated. Although the test was started on December 1, 1994, only part of the first cycle was completed on this day. On the next day this test for these two piles was completed. See Appendix E "Site 1-Piles 1 and 2-Lateral Load Test Plots". The maximum load achieved during this test was 156 kN (35 kips), and there were 10 cycles total with the slope inclinometers read on four of the cycles.

As can be seen in the plot "Lateral Load-Displacement Near Pile Top-Test Site 1, Pile 1 (Test 2)", Appendix E, the shape of the curve was not typical of a lateral load test. There appeared to be some uneven loading of the load cell in its original position in the lateral head assembly. In the plan view of the lateral load test set-up, the original location of the load cell for pile 1 was on the lateral head assembly for pile 1 on the short high strength thread bar. At the zero reading after the eighth cycle, the load cell was moved to the location on the assembly noted as "2 of 2-50 kip Donut Load Cells". This location proved superior in allowing the load cell to be evenly loaded. As seen in the plot labeled "Lateral Load-Displacement Near Pile Top-Test Site 1, Pile 2 (Test 2)" this pile was restrained from

lateral movement inside the 6.1 m (20 ft) deep casing. Table 2-"Site 1 Installation Details" includes soundings (measurements from the top of the casing to the mud inside the casing). All of the soundings taken for all Sites showed that mud was inside the casing. Soundings were taken before and immediately after pile installation. After installation, a drill rig was brought in to drill out material between the pile and the casing to a depth equal to the bottom of the casing. Soundings not included in Table 2 were soundings that showed that sufficient material had been removed from between the pile and the casing, and that the top of the remaining material was at the elevation of the bottom of the casing.

The second lateral test was performed on piles 3 and 4 on December 6, 1994. 10 cycles were performed with the slope inclinometers read on three cycles. The slope inclinometers were read on the first, third and tenth cycle and the maximum load achieved during this test was 178 kN (40 kips). See Appendix F "Site 1, Piles 3 and 4, Lateral Load Test Plots" for the Lateral Load - Time History, Displacement Near The Pile Top, Slope Inclinometer Summary Tables, Slope Inclinometer Casing Rotation Plots, and finally Slope Inclinometer and Surface Displacement Measurement Plots for the direction of the applied lateral load and transverse to the direction of the applied lateral load for piles 3 and 4.

Static Axial Load Testing

The axial load tests were performed following the lateral load tests at this site. A static axial compression test was performed on December 9, 1994, on pile 5, see Photograph Number 6 in Appendix B. The maximum load for cycles 1 through 5 was 1070, 1780, 2140, 2310 and 3200 kN (240, 400, 480, 520 and 720 kips), respectively. The displacement at 3200 kN (720 kips) was 41.9 mm (1.65 in), with permanent displacement of 34.3 mm (1.35 in) at the end of the test. The axial tension test was performed on pile 5 on December 12, 1994. The maximum load for cycles 1, 2 and 3 were 450, 710 and 1330 kN (100, 160 and 300 kips), respectively. The maximum displacement in the tension test at a load of 1334 kN (300 kips) was 33.5 mm (1.32 in), and the permanent displacement at the end of the test was 29.2 mm (1.15 in). In both the tension and compression test higher loads were possible as seen by the shapes of the curves in Appendix D, however, the permanent displacements experienced during these tests were well beyond practical applications.

The driven pile, pile 6, at Site 1 was only tested in tension and the maximum load for cycle 1 and 2 was 1330 and 1510 kN (300 and 340 kips) respectively. The maximum displacement at the maximum load of 1510 kN (340 kips) was 34.3 mm (1.35 in). The permanent displacement at the end of cycle 1 was 5.1 mm (0.20 in), and 5.3 mm (1.20 in) at the end of cycle 2.

Table 4 - Site 1 Axial Load Testing Summary

	Set-up Time[a]	Failure Load at Caltrans' 12.7 mm (1/2 in) Failure Criterion kN (kips)	Failure Load at Davisson's Failure Criterion kN (kips)	Ultimate Load kN (kips)
Pile 5 Comp. Test	23 days	2490 (560)	2490 (560)	3200 (720)[b]
Pile 5 Tension Test	26 days	800 (180)	N/A	1330 (300)[b]
Pile 6 Tension Test	7 days	1510 (340)	N/A	1510 (340)

a Set-up time is the number of days between the date of installation and the date of testing.
b Ultimate Load is based on pile plunging or pull-out, however, in this case higher loads could have been achieved with much higher displacements.

Pile Extraction

Pile extraction began on December 29, 1994 by setting up the 5 pile group for a tension test on pile 5 (the center test pile), see Pile Extraction Plot in Appendix D. A 1670 kN (300 ton) hydraulic jack with a 152 mm (6 in) maximum ram displacement was used to pull the pile. The pile would be jacked out of the ground 152 mm (6 in) at a time until the load required to move the pile was below 400 kN (90 kips) which was the capacity of the on-site crane. The maximum load attained during the first cycle was 2470 kN (555 kips). During each successive cycle, the load dropped and by cycle 13, the pile had been pulled out 1.6 m (5'-2") and the load required to move the pile was 400 kN (90 kips). This displacement was also the maximum for this set-up. On December 30, 1994, the 400 kN (45 ton) crane was moved into position and began pulling on the pile. The crane pulled on the pile for several hours and pulled the pile 178 mm (7 in), but the pile stopped moving during the last half hour. Pile extraction resumed on January 4, 1995 after 1830 mm (6 ft) of the pile was cut-off leaving 13.0 m (42.8 ft) with 610 mm (2 ft) stick-up in an 5.5 m (18 ft) cased hole. Again, the 2670 kN (300 ton) hydraulic jack was used to pull the pile out 152 mm (6 in) at a time (cycle), and the pile was pulled out another 2.4 m (7'-9"). The 400 kN (45 ton) crane was then able to lift the pile out of the ground. There was no grout on the outside of the pile. It appears that the grout stayed in place while the bond between the pile and the grout broke, see Photograph Number 8 in Appendix B.

Site 2

Pile Installation

Site 2 (Pile 5) is located at 15 m (48 ft) north of Station 280+68 for the I-80 San Francisco - Oakland Bay Bridge. This is in line and north of Bent E32, see Site Plan 2 in Appendix A. Pile 2 was the first pile installed at Site 2, see "Fundex Pile Installation Records" in

Appendix C, and Table 5, "Site 2 Installation Information". Also, at the beginning of this Appendix is the "Fundex Drill Table Torque Graph", which shows the relationship between the bar readings shown in the installation records and the actual torque. The ground surface elevation was 4.3 m (14 ft), the specified tip elevation was -13.7 m (-45 ft), and the piles were installed in a 8.5 m (28 ft) long casing. Piles 1 and 2 were installed by grouting during drilling, and piles 3, 4 and 5 were installed by only grouting once the pile tip was within 3.0 m (10 ft) of the specified tip elevation. However, a volume of grout that would fill the annular space between the pile and the soil for the entire length of the pile was used. Pile 2 was installed on November 28, 1994, and was completed in 4 hours and 52 minutes. Pile 2 and pile 1 were made of 12.7 mm (1/2 in) wall thickness pipe, and with the 0.9 m (3 ft) stick-up above the ground surface, was 18.9 m (62 ft) in length. The spliced lengths were 12.2, 3.4 and 3.4 m (40, 11, and 11 ft) for piles 1 and 2.

Pile 4 was installed next on November 29, 1994, and was completed in 3 hours and 55 minutes. Piles 3, 4 and 5 were made up of 11.3 m of 12.7 mm (37 ft of 1/2 in) wall thickness pipe in the lower portion, and 7.6 m of 19 mm (25 ft of 3/4 in) wall thickness pipe in the upper portion, including the stick-up. The spliced lengths for piles 3, 4 and 5 were 11.3, 3.8 and 3.8 m (37, 12.5, and 12.5 ft). Pile 5 was also started on November 29, but was completed the next day. The ability to start a pile one day and complete it another was mentioned above as one of the advantages of the "post" grouting technique. Total installation time for pile 5 was 4 hours and 33 minutes. After pile 5 was completed on November 30, pile 3 was installed and completed that day in 4 hours and 29 minutes. The last pile installed at this Site was pile 1. This pile was installed on December 1, and was completed in 4 hours and 24 minutes.

Table 5 - Site 2 Installation Information

	Date Installed	Date Tested	Specified/ Actual Tip El. m (ft)	Installation Time (hours)	Projected Installation Time (hours)[b]
Pile 1	12/1/94	12/14/94	-13.7/-13.7 (-45/-45.0)	4.4	6.2
Pile 2	11/28/94	12/14/94	-13.7/13.7 (-45/-44.9)	4.9	6.8
Pile 3	11/30/94	12/15/94	-13.7/-13.7 (-45/-45.0)	4.5	5.4
Pile 4	11/29/94	Lateral 12/15/94 Tension 1/3/95	-13.7/13.8 (-45/-45.2)	3.9	5.4
Pile 5	11/29-11/30/94	Comp. 12/21-22/94 Tension 12/22/94	-13.7/-13.7 (-45/-45.0)	4.6	5.6

a This installation time is based on 3.7 m (12 ft) sections. Piles 3, 4 and 5 were installed using post grouting techniques. Piles 1 and 2 were installed by grouting during drilling.

b The projected installation time is based on 2.7 m (9 ft) sections and assumes that post grouting techniques will be used.

All piles at this Site were able to penetrate to the specified tip elevation with no significant problems, break-downs or delays. Note from Table "Site 2 Installation Details", that each of the piles that were grouted the entire length used 4 batches of grout while the piles installed with the "post" grouting method used 3 batches.

As with Site 1, at the conclusion of pile installation, the area between the casing and the pile was drilled out. Table 5 - Site 2 - Pile Installation Details shows the soundings that were performed before and after pile installation and before testing. After the casings were vibrated to depth, they were drilled out completely to the bottom of the casing as determined by soundings since the casing was filled with water. However, after settlement, all of the casings had between 0 and 0.5 m (0 and 1.5 ft) of mud in the bottom. It was decided to remove all of this material after installation.

After pile installation (as stated in Table 5) the total amount of material in the bottom of the casings consisted of sediment from casing installation, heave and grout from pile installation and amounted to as much as 1.4 m (4.5 ft). As with Site 1 soundings performed a day after installation showed that the very top layer of material in the casing was hard grout.

Drilling between the piles and the casings required three days and several different kind and size drill bits. The types of drill bits used were core barrels and spin augers.

Soundings were performed during drilling and confirmed that this area was cleaned out, see Photograph No. 10 in Appendix B. However, soundings taken just before testing showed that again there was a substantial amount of material in this area. It is very unclear how much of this material is from settlement from the drilling operation, or how much, if any, was from heaving of material from outside the casing into the casing.

All Site 2 piles were poured on December 5, 1994. Concrete strengths were determined by 8 and 29 day breaks with two 152 mm by 305 mm (6 in by 12 in) cylinders for each break. The average concrete strengths for the 8 and 29 day breaks were 21.9 and 37.4 MPa (3180 and 5420 psi).

Table 6 - Site 2 Installation Details

	Grout Batches Used[a]	Depth to Mud from Top of Casing Before Pile Installation[b] m (ft)	Depth to Mud from Top of Casing After Pile Installation m (ft)	Depth to Mud from Top of Casing Before Testing[c] m (ft)
Pile 1	4	8.1 (26.5)	7.2 (23.6)	7.7 (25.2)
Pile 2	4	8.5 (28.0)	7.3 (24.0)	8.0 (26.1)
Pile 3	3	8.1 (26.5)	7.2 (23.5)	7.4 (24.2)
Pile 4	3	8.7 (28.5)	7.3 (24.0)	7.7 (25.2)
Pile 5	3	8.1 (26.5)	7.5 (24.5)	7.0 (23.1)

a A grout batch equals 300 L (80 gal) of grout or 0.3 m^3 (10.7 ft^3)
b Drilled to bottom of casing depth of 8.5 m (28 ft) before pile installation.
c The annular space between the pile and the casing was cored and augered with a drill rig to a depth of 8.5 m (28 ft) after pile installation and before any testing.

Lateral Load Testing

The first lateral load test at this Site tested piles 1 and 2. The test was performed on December 14, 1994. See Appendix G "Site 2-Piles 1 and 2-Lateral Load Test Plots". The maximum load achieved during this test was 111 kN (25 kips), however, it was quickly determined that this load could not be attained during subsequent load cycles due to creep so that 89 kN (20 kips) was used as the maximum load for the remainder of the load cycles. There were 10 cycles total with the slope inclinometers read on three of the cycles.

The second lateral test was performed on piles 3 and 4 on December 15, 1994. 10 cycles were performed with the slope inclinometers read on three of the cycles. The slope inclinometers were read on the first, third and tenth cycle and the maximum load achieved during this test was 89 kN (20 kips). See Appendix H "Site 2, Piles 3 and 4, Lateral Load Test Plots".

Table 7 - Site 2 Pile Wall Thickness

	12.7 mm (1/2 in) Wall Thickness From El. To El. m to m (ft to ft)	19 mm (3/4 in) Wall Thickness From El. To El. m to m (ft to ft)	Length of 12.7 mm (1/2 in) Wall Thickness m (ft)	Length of 19 mm (3/4 in) Wall Thickness m (ft)
Pile 1	-13.7 to 5.2 (-45 to +17)		18.9[a] (62)	
Pile 2	-13.7 to 5.2 (-45 to +17)		18.9[a] (62)	
Pile 3	-13.7 to -2.4 (-45 to -8)	-2.4 to 5.2 (-8 to +17)	11.3 (37)	7.6[a] (25)
Pile 4	-13.9 to -2.6 (-45.5 to -8.5)	-2.6 to 5.2 (-8.5 to +17)	11.3 (37)	7.6[a] (25)
Pile 5	-13.7 to -2.4 (-45 to -8)	-2.4 to 5.2 (-8 to +17)	11.3 (37)	7.6[a] (25)

a This length includes a pile stick-up above the ground surface of approximately 0.9 m (3 ft)

Static Axial Load Testing

At the conclusion of the lateral load tests at this site, concerns were raised over the grout set-up time for the tension tests at Site 2 and 3. Since the amount of grout set-up time is not as important in the lateral load tests as it is for the tension tests, the testing schedule was shifted to allow for more grout set-up time for the tension tests. The order of testing was changed as follows: lateral load testing at Site 2, lateral load testing at Site 3, then static axial load testing at Site 2, and finally, static axial load testing at Site 3.

A static axial compression test was performed on December 21 on pile 5. The maximum load for cycles 1, 2, 3 and 4 was 1157, 1334, 1380 and 1334 kN (260, 300, 310 and 300 kips), respectively. The displacement at 1380 kN (310 kips) was 35.6 mm (1.40 in), with permanent displacement of 30.5 mm (1.2 in) at the end of cycle 3. As can be seen in Appendix D "Axial Static Load test Plots", a malfunctioning load cell recorded slightly negative readings at the end of cycles 1, 2 and 3. To verify the validity of the measurements, a different load cell was used to run another compression test with only one cycle on the next day. Cycle 4 is the result of the second compression test. As can be seen in the plot, cycle 4 is very similar to cycle 3, which validates the data collected in the previous days compression test.

The axial tension test was performed on pile 5 on December 22. The maximum load for cycles 1, 2 and 3 was 360, 530 and 890 kN (80, 120 and 200 kips), respectively. The maximum displacement in the tension test at a load of 1330 kN (300 kips) was 85.1 mm (3.35 in), and the permanent displacement at the end of the test was 80.0 mm (3.15 in). This tension test was carried out to such a large displacement because, as can be seen in the plot,

there was significant creep at loads below 450 kN (100 kips), but less creep at higher loads. This produced an atypical curve. In seems that for this pile, the performance of the compression test caused a large permanent displacement which significantly affected the load-displacement behavior in the tension test. Although the tensile capacity was less than expected, the pile tip was pulled up past its original position before the compression test.

Because of the lower than expected loads seen in the tension test, another tension test was performed on a different pile, pile 4. This pile was chosen over piles 1 and 2 because it was installed using the same methods, and has the same lengths of different pile wall thicknesses as pile 5. Note that pile 4 was previously tested laterally and it was loaded to approximately 335 kN (75 kips) in tension in its role as a reaction pile during the compression test. This pile was most recently loaded to approximately 294 kN (66 kips) in compression as a reaction pile in the tension test. The tension test for pile 4 was performed on January 3, 1995. The maximum load for cycles 1, 2 and 3 was 445, 890 and 1335 kN (100, 200 and 300 kips), respectively. The maximum displacement in the tension test at a load of 1335 kN (300 kips) was 44.5 mm (1.75 in), and the permanent displacement at the end of the test was 38.1 mm (1.50 in).

Table 8 - Site 2 Axial Load Testing Summary

	Set-up Time[a]	Failure Load at Caltrans' 12.7 mm (1/2 in) Failure Criterion kN (kips)	Failure Load at Davisson's Failure Criterion kN (kips)	Ultimate Load kN (kips)
Pile 5 Comp. Test	21 days	1330 (300)	1330 (300)	1330 (300)
Pile 5 Tension Test	22 days	360 (80)	N/A	890 (200)
Pile 4 Tension Test	35 days	1250 (280)	N/A	1330 (300)

a Set-up time is the number of days between the date of installation and the date of testing.

Site 3

Pile Installation

Site 3 (Pile 5) is located at 48 ft north of Station 282+75 for the I-80 San Francisco - Oakland Bay Bridge. This is in line and north of Bent E32, see Site Plan 3 in Appendix A. Pile 3 was the first pile installed at Site 3, see "Fundex Pile Installation Records" in Appendix C, and Table 9, "Site 3 Installation Information". Also, at the beginning of this Appendix is the "Fundex Drill Table Torque Graph", which shows the relationship between the bar readings shown in the installation records and the actual torque. The ground surface elevation was 3.7 m (12 ft), the specified tip elevation was -19.8 m (-65 ft), and the piles were installed in a 8.2 m (27 ft) long casing. Piles 1 and 2 were installed by grouting during drilling, and piles

3, 4 and 5 were installed by only grouting once the pile tip was within 3.0 m (10 ft) of the specified tip elevation. However, a volume of grout that would fill the annular space between the pile and the soil for the entire length of the pile was used.

Pile 3 was installed on December 5, 1994, and was completed in 6 hours and 58 minutes. Piles 3, 4 and 5 were made up of 17.4 m of 12.7 mm (57 ft of 1/2 in) wall thickness pipe in the lower portion, and 7.0 m of 19 mm (23 ft of 3/4 in) wall thickness pipe in the upper portion, including the stick-up. The spliced lengths for piles 3, 4 and 5 were 12.2, 2.6, 2.6, 3.4 3.7 m (40, 8.5, 8.5, 11 and 12 ft). Pile 1 was installed next on December 6, 1994, and was completed in 6 hours and 13 minutes. Pile 2 and pile 1 were made of 12.7 mm (1/2 in) wall thickness pipe, and with the 0.9 m (3 ft) stick-up above the ground surface, was 24.4 m (80 ft) in length. The spliced lengths were 12.2, 3.0, 3.0, 3.0 and 3.0 m (40, 10, 10, 10, and 10 ft) for piles 1 and 2. The third pile installed at Site 3 was pile 5 on December 7, and it was installed in just over 7 hours. Pile 2 was installed on December 8, in 5 hours and 54 minutes. The last pile installed at this Site was pile 4. This pile was installed on December 9, and was completed in just over 7 hours.

Table 9 - Site 3 Installation Information

	Date Installed	Date Tested	Specified/ Actual Tip El. m (ft)	Installation Time (hours)[a]	Projected Installation Time (hours)[b]
Pile 1	12/6/94	12/19/94	-19.8/-19.8 (-65/-64.8)	6.2	8.3
Pile 2	12/8/94	12/19/94	-19.8/-19.8 (-65/-65)	5.9	8.3
Pile 3	12/5/94	12/20/94	-19.8/-19.7 (-65/-64.5)	7.0	8.3
Pile 4	12/9/94	12/20/94	-19.8/-19.8 (-65/-65)	7.1	8.3
Pile 5	12/7/94	12/27/94	-19.8/-19.8 (-65/-65)	7.0	8.3

a This installation time is based on 3.7 m (12 ft) sections. Piles 3, 4 and 5 were installed using post grouting techniques. Piles 1 and 2 were installed by grouting during drilling.

b The projected installation time is based on 2.7 m (9 ft) sections and assumes that post grouting techniques will be used.

All piles at Site 3 were able to penetrate to the specified tip elevation with no significant problems. Note from Table 10 "Site 3 Installation Details", that each of the piles that were grouted the entire length used 5 batches of grout while the piles installed with the "post" grouting method used 4 batches.

All Site 3 piles were poured on December 13, 1994. Concrete strengths were determined by 7 and 28 day breaks with two 152 mm by 305 mm (6 in by 12 in) cylinders for each break.

The average concrete strengths for the 7 and 28 day breaks were 23.2 and 39.9 MPa (3360 and 5790 psi).

As with Site 1 and 2, at the conclusion of pile installation, the area between the casing and the pile was drilled out. Table 10 - Site 3 - Pile Installation Details shows the soundings that were performed before and after pile installation and before testing. After the casings were vibrated to depth, they were drilled out completely to the bottom of the casing. However, after settlement, all of the casings had between 0 and 0.9 m (0 and 3 ft) of mud in the bottom.

After pile installation (as stated in Table 10) the total amount of material in the bottom of the casings consisted of sediment from casing installation, heave and grout from pile installation and amounted to as much as 1.5 m (5 ft). As with Site 1 and 2 soundings performed a day after installation showed that the very top layer of material in the casing was hard grout.

Drilling between the piles and the casings required three days and several different kind and size drill bits. The types of drill bits used were core barrels and spin augers. Soundings were performed during drilling and confirmed that this area was cleaned out, see Photograph No. 10 in Appendix B. However, soundings taken just before testing showed that again there was a substantial amount of material in this area, up to 2.1 m (7 ft). It is very unclear how much of this material is from settlement from the drilling operation, or how much, if any, was from heaving of material from outside the casing into the casing.

Table 10 - Site 3 Installation Details

	Grout Batches Used[a]	Depth to Mud from Top of Casing Before Pile Installation[b] m (ft)	Depth to Mud from Top of Casing After Pile Installation m (ft)	Depth to Mud from Top of Casing Before Testing[c] m (ft)
Pile 1	5	7.6 (25)	7.0 (23)	7.6 (24.8)
Pile 2	5	8.2 (27.0)	7.2 (23.5)	7.8 (25.5)
Pile 3	4	7.6 (25)	7.0 (23)	7.0 (22.9)
Pile 4	4	7.3 (24)	6.7 (22)	6.4 (21.0)
Pile 5	4	7.6 (25)	7.2 (23.5)	6.8 (22.2)

a A grout batch equals 300 L (80 gal) of grout or 0.3 m^3 (10.7 ft^3)
b Drilled to bottom of casing depth of 8.2 m (27 ft) before pile installation.
c The annular space between the pile and the casing was cored and augered with a drill rig to a depth of 8.2 m (27 ft) after pile installation and before any testing.

Lateral Load Testing

The first lateral load test at this Site tested piles 1 and 2. The test was performed on December 19, 1994. See Appendix I "Site 3-Piles 1 and 2-Lateral Load Test Plots". The

maximum load achieved during this test was 111 kN (25 kips), and there were 10 cycles total with the slope inclinometers read on three of the cycles.

The second lateral test was performed on piles 3 and 4 on December 20, 1994. 10 cycles were performed with the slope inclinometers read on three of the cycles. The slope inclinometers were read on the first, third and tenth cycle and the maximum load achieved during this test was 111 kN (25 kips). See Appendix J "Site 3, Piles 3 and 4, Lateral Load Test Plots". As can be seen in the plot "Lateral Load - Displacement Near Pile Top", Pile 4 seemed to be laterally restrained until a load of 76 kN (17 kips). At this load the pile moved several inches horizontally without any increase in load. This cycle was then abandoned and cycle 1 with slope inclinometer readings every 22 kN (5 kips) was repeated. Such a change in stiffness was is probably due to a loose chunk of grout between the casing and the pile. At a load of 76 kN (17 kips) the chunk broke and the soil/pile stiffness returned to normal.

Table 11 - Site 3 Pile Wall Thickness

	12.7 mm (1/2 in) Wall Thickness From El. To El. m to m (ft to ft)	19 mm (3/4 in) Wall Thickness From El. To El. m to m (ft to ft)	Length of 12.7 mm (1/2 in) Wall Thickness m (ft)	Length of 19 mm (3/4 in) Wall Thickness m (ft)
Pile 1	-19.8 to 4.6 (-64.8 to +15)		24.3[a] (79.8)	
Pile 2	-19.8 to 4.6 (-65 to +15)		24.4[a] (80)	
Pile 3	-19.7 to -2.3 (-64.5 to -7.5)	-2.3 to 4.6 (-7.5 to +15)	17.4 (57)	6.9[a] (22.5)
Pile 4	-19.8 to -2.4 (-65 to -8)	-2.4 to 4.6 (-8 to +15)	17.4 (57)	7.0[a] (23)
Pile 5	-19.8 to -2.4 (-65 to -8)	-2.4 to 4.6 (-8 to +15)	17.4 (57)	7.0[a] (23)

a This length includes a pile stick-up above the ground surface of approximately 0.9 m (3 ft)

Static Axial Load Testing

A static axial compression test was performed on December 27 on pile 5, see Appendix D "Axial Static Load Test Plots". The maximum load for cycles 1 and 2 was 710 and 1070 kN (160 and 240 kips), respectively. The displacement at 1070 kN (240 kips) was 46.2 mm (1.82 in), with permanent displacement of 1.58 in at the end of cycle 2.

The axial tension test was also performed on pile 5 and also on December 27. The maximum load for cycles 1, 2 and 3 was 445, 800 and 890 kN (100, 180 and 200 kips), respectively. The maximum displacement in the tension test at a load of 890 kN (200 kips)

was 39.6 mm (1.56 in), and the permanent displacement at the end of the test was 33.0 mm (1.30 in).

Table 12 - Site 3 Axial Load Testing Summary

	Set-up Time[a]	Failure Load at Caltrans' 12.7 mm (1/2 in) Failure Criterion kN (kips)	Failure Load at Davisson's Failure Criterion kN (kips)	Ultimate Load kN (kips)
Pile 5 Comp. Test	20 days	980 (220)	890 (200)	1070 (240)
Pile 5 Tension Test	20 days	620 (140)	N/A	890 (200)

a Set-up time is the number of days between the date of installation and the date of testing.

Laboratory Testing

During the pile pour at Site 3, a 6.1 m (20 ft) length of 510 mm (20 in) diameter Fundex pipe pile with a plate tacked on the bottom, was filled with concrete while in a vertical position, and the top 4.6 m (15 ft) was vibrated. This pile section was then transported to the Caltrans' Laboratory for testing. A four point load test was conducted for this sample pile in order to determine bending stiffness. The results of this testing are presented in Appendix L.

Interpretation of Axial Load Test Data

In this report the pile failure load is equal to the ultimate pile capacity. This report presents estimates of ultimate geotechnical capacity based on two failure criteria. Caltrans defines the pile failure load as the force applied to the pile butt which induces a 12.7 mm (1/2 in) of pile deflection, and this definition of failure is referred to as Caltrans' 12.7 mm (1/2 in) failure criterion. The Ultimate compressive pile capacity according to Davisson's criterion is equal to the force applied to the pile butt which induces a total pile butt deflection equal to (PL/AE) + D/120 + 3.8 solve for mm [(PL/AE) + D/120 + 0.15 solve for inches], where:

P = Load applied to pile butt [kN (kips)]

L = Length of pile [m (ft)]

A = Cross sectional area of pile [m^2 (ft^2)]

E = Modulus of elasticity of pile [kN/m^2 (ksi)]

D = Diameter of pile [mm (in)]

For Site 1, the vertical load test pile (pile 5) developed an ultimate compressive capacity of 2500 kN (560 kips)as determined by Caltrans' 12.7 mm (1/2 in) Failure Criterion. This is

the same capacity as determined by Davisson's Failure Criterion. The maximum load during this test was 3200 kN (720 kips), but as can be seen from the plot of these test results (Appendix D) higher loads could have been achieved, but the displacement from these higher loads would have been out of the range useful for the parent retrofit project. The tension capacity pile 5, Site 1, is 800 kN (180 kips) based on the 12.7 mm (1/2 in) Caltrans' Failure Criterion. This test was similar to the compression test in that pile load continued to increase with displacement in excess of 13 mm (1/2 in), however, as before, the measured displacements would have been excessive for the parent project. The maximum tension load for this pile was 1340 kN (300 kips).

For Site 1, pile 6, the load based on the 12.7 mm (1/2 in) Caltrans' Failure Criterion in tension was 1510 kN (340 kips) which was also the ultimate load based on pile pull-out.

For Site 2, pile 5, the load based on the 12.7 mm (1/2 in) Caltrans' Failure Criterion in compression was 1330 kN (300 kips).. This was also the ultimate load based on pile plunging and the failure load based on Davisson's Failure Criterion. This load was less than expected and may be due to a thinner than expected sand layer that allowed the pile to punch through to a soft clay during the compression test. The sand layer in question is labeled "Dense Lower Merritt Sand" in the Soil Profile in Appendix A "Design Details" using the color green. This sand layer pinches out heading east and north and this variability was the reason for choosing this site as one of the test sites.

For pile 5, Site 2, the results of the tension test were less than expected with 360 kN (80 kips) at 12.7 mm (1/2 in) displacement. The ultimate load is defined as 890 kN (200 kips) for this test but the shape of the load - displacement curve shows that higher loads are possible with accompanying higher displacement. The ultimate load achieved during this test was not based on pile pull-out. However, the shape of this tension curve is unusual in that for a relatively stiff pile to have an ultimate load which is so much larger than the load at 12.7 mm (1/2 in).

The tension test on pile 4, Site 2, which was installed using the same techniques, yielded much better results. The load based on the 12.7 mm (1/2 in) Caltrans' Failure Criterion was 1250 kN (280 kips), and the ultimate based on pile pull-out was 1330 kN (300 kips). The differences between these two piles is that the tension test for pile 5 was preceded by a compression test that moved the pile over 75 mm (3 in), and the tension test for pile 4, Site 2, was preceded by a lateral load test, and the set-up time for pile 5 was 22 days and the set-up time for pile 4 was 35 days.

For Pile 5, Site 3, the Davisson's Failure Load in compression was 890 kN (200 kips), and the load at the 12.7 mm (1/2 in) Caltrans' Failure Criterion was 980 kN (220 kips). The ultimate compressive load based on pile plunging was 1070 kN (240 kips).

The tensile load at the 12.7 mm (1/2 in) Caltrans' Failure Criterion was 620 kN (140 kips), and the ultimate tensile load based on pile pull-out was 890 kN (200 kips).

Table 13 - Summary of Compressive Load Test Results Based on Caltrans' Failure Criterion

	Site 1 kN (kips)	Site 2 kN (kips)	Site 3 kN (kips)
Compression	Pile 5-2490 (560)	Pile 5-1330 (300)	Pile 5-980 (220)

Table 14 - Summary of Tensile Load Test Results Based on Caltrans' Failure Criterion

	Site 1	Site 2	Site 3
Tension	Pile 5-800 (180) Pile 6-1510 (340)	Pile 5-360 (80) Pile 4-1250 (280)	Pile 5-620 (140)

Fundex Rig Observations

1. The Fundex rig must sit at the same ground surface elevation as the piles it is installing. In most retrofit projects, there is a small excavation around the existing pile cap, and piles are driven or drilled in this excavation and the machinery that drives or drills these piles sits outside the excavation. However, the Fundex rig must be very close to the pile it is installing which requires that it sit at the same ground surface elevation.

2. The drill point can only be welded to the pile after the pile is inserted into the jaws of the drill table. In starting a new pile, a fork lift brings a pile, with a grout pipe inside, to the Fundex rig and inserts it through the jaws of the drill table. Then the grout pipe can be welded to the drill point and then the drill point can be welded to the pile. This welding takes approximately 60 minutes.

3. Several short delays occur during installing the last 3.0 m (10 ft). The grout plant can only store two 300 L (80 gal) batches of grout. In the method that pumps grout during drilling the entire length, short delays do not occur. However, using the "post" grouting technique, many batches of grout must be pumped to fill the annular space from the pile tip to the ground surface. Since the grout plant only has two tanks (one for holding and one for mixing) drilling must be halted while grout is mixed. A batch takes approximately 30 minutes from start to end. It takes 5 minutes to pour in the ingredients, 15 minutes of mixing, and 10 minutes to pump.

Conclusions

Pile testing results from this Indicator Pile Test Program satisfy the testing requirements for the axial pile performance testing required during construction of the parent retrofit contract. However, this is only true for Fundex piles installed in the methods described in this report. Any pile system other than Fundex that meets the requirements of the contract must undergo performance testing.

The lateral load test plots shown in Appendices E through J are the final products of the lateral load testing. Further manipulation, interpretation or conclusions from this data will

be done by the Earthquake Engineering Section in the Office of Structural Foundations and the Office of Structures Design.

Pile 5 at Site 1 was extracted in order to determine the consistency in the thickness of the grout. However, the extraction removed all of the grout around the pile.

The Site 1 axial load test results were as expected for the compression and tension load test on pile 5. There is, however, an indication that the compression test affected the results of the tension test. As can be seen in the Static Tension Load Test Plot in Appendix D, there is a large amount of creep at the 800 kN (180 kip) load. Creep at subsequently higher loads is significantly less. It is therefore reasonable to assume that a better estimate of the tensile capacity could be made if the compression and tension tests are performed on different piles. However, for seismic loading, in which a pile will be subject to loading in both directions, testing separate piles may not be an appropriate method of determining axial pile capacity. It is important to point out that there were 3 days between the compression and tension test. This time probably helped to minimize the impact the compression test had on the tension test.

At Site 1 the tension capacity of the driven pile (pile 6) (1510 kN (340 kips) at 12.7 mm compared with 800 kN (180 kips) for the Fundex pile). Pile 6 had less than a third of the set-up time as the Fundex axial load test pile, and the driven pile (pile 5) has a smaller diameter than the Fundex pile-610 mm (24 in) for the driven pile compared with 660 mm (26 in) for the Fundex pile. The difference here is that the driven pile was tested at the specified tip elevation of -12.2 m (-40 ft), while the Fundex tension pile (pile 5) stopped 1.5 m (4.8 ft) short of specified tip elevation. This is a substantial difference due to the small penetration length [9.1 m (30 ft) with the pile at specified tip elevation] and the fact that the last 3.0 m (10 ft) of penetration was into dense sand.

The axial compression load test results showed that at Site 2 end bearing from the "Dense Lower Merritt Sand", from the Soil Profile in Appendix A, is not available with this tip elevation. An issue at this site is why the tension test results were lower than expected. In this case as with pile 5 at Site 1, it appears that performing the compression test before the tension test affected the tension test results. It appears that the compression test caused the tension test to have higher displacements for particular loads.

The effect of the compression test on the tension test with regards to the ultimate load based on pile pull-out is probably insignificant. As can be seen in the Load Displacement Behavior plot in Appendix D for Site 2, Pile 5, the total movement of the tension test exceeded that of the compression test, and that pull-out consisted of over 10 mm (0.4 in) of displacement without any increase in load.

The results of the tension test on pile 4 at Site 2 were in line with expected results. However, it is unusual that the ultimate load for both the compression test of pile 5 and the tension test on pile 4 was 1335 kN (300 kips), since there must be some component of end bearing in the compression test. Possible explanations for this include minor variations in the grout on the outside of the pile, and the longer set-up time in the tension test for pile 4 (35 days) than the compression test on pile 5 (21 days).

Advantages and Disadvantages of Laterally Load Testing Cased Piles

The piles is this indicator pile test program were cased so that sheet piling would not have to be used. The location of the pile displacement of interest is at the bottom of the casing. If sheet piling was used, the volume of soil within the sheet piling would have to be removed and treated at hazardous waste at great expense and time. Also, since the elevation of the bottom of the casings at each site are well below the water table, large quantities of contaminated water would seep in and have to be pumped out and stored on site 24 hours per day, 7 days per week. Furthermore, workers in this environment would be exposed to contaminated water and soil, and the hazards of a catastrophic failure of the bottom of the excavation (mud flow) caused by the incredible pressure of the high water table soil. Installing slurry seal would not be possible since the piles must be free to move in the horizontal direction.

Testing cased piles, however, created a whole new set of problems. Since the pile displacement of interest is at the bottom of the casing, the top of the pile had to be moved a large distance, about 500 mm (20 in). Since typical lateral load tests require displacement on the order of 50 mm (2 in), moving a pile 500 mm (20 in) required obtaining special "Houston Pots" which are wire line displacement gauges that can accurately measure displacements up to 760 mm (30 in). Another problem caused by the large displacements required for the lateral load testing was that the pile top would be pulled over to such a large degree that the hydraulic jacks could not be safely installed on top of the piles. Therefore, an elaborate set-up had to be designed that would allow the piles to be pulled over 5 degrees and keep the hydraulic jacks in a horizontal plane.

The large lateral displacement required for one test is doubled since two piles were tested at one time. The total lateral displacement of the piles is then 1 020 mm (40 in) and necessitated the use of two 610 mm (24 in) throw center pull hydraulic jacks used in series. These jacks have the required ram displacement, but have 10 times more capacity than required.

The non-slope inclinometer reading cycles used in the lateral load tests had only the requirement that the data acquisition system read a point at least every 5 kips. That means that on a test to 25 kips, only 11 readings were necessary requiring only less than 3 minutes. However, the jacks required such a large volume of hydraulic fluid that this cycle was performed in 40 minutes.

Casing the piles also created the problem of cleaning out mud between the pile and the casing. As was stated earlier, even after 3 days of drilling per site, sediment between the pile and the casing was still noted.

Installation Costs

In this Indicator Pile Test Program the main objective was static axial and lateral pile load test results. However, the constructability issues stated below will have a much greater impact on raising the cost of the parent retrofit project.

Installation costs for these piles were significantly higher than previously estimated. The reasons for the increased costs are as follows:

1. The contractor had estimated that a crew of 5 was needed to install these piles, but it was later discovered that number did not include the cost of a Superintendent and 2 Welders.

2. The contractor had estimated that splice times were 1 hour (which is why splice simulation hold times for the sample pile were 1 hour), but the splice times averaged 90 minutes for 13 mm and 19 mm (1/2 in and 3/4 in) wall thickness piles. Note that most wall thicknesses will be increased by 6.4 mm (1/4 in) for the parent retrofit project to account for corrosion.

3. The contractor had estimated that it would be possible to install 2 piles per day to specified tip elevation, but only 1 pile could be installed per day without significant overtime and no pile at Site 1 was able to penetrate to specified tip elevation.

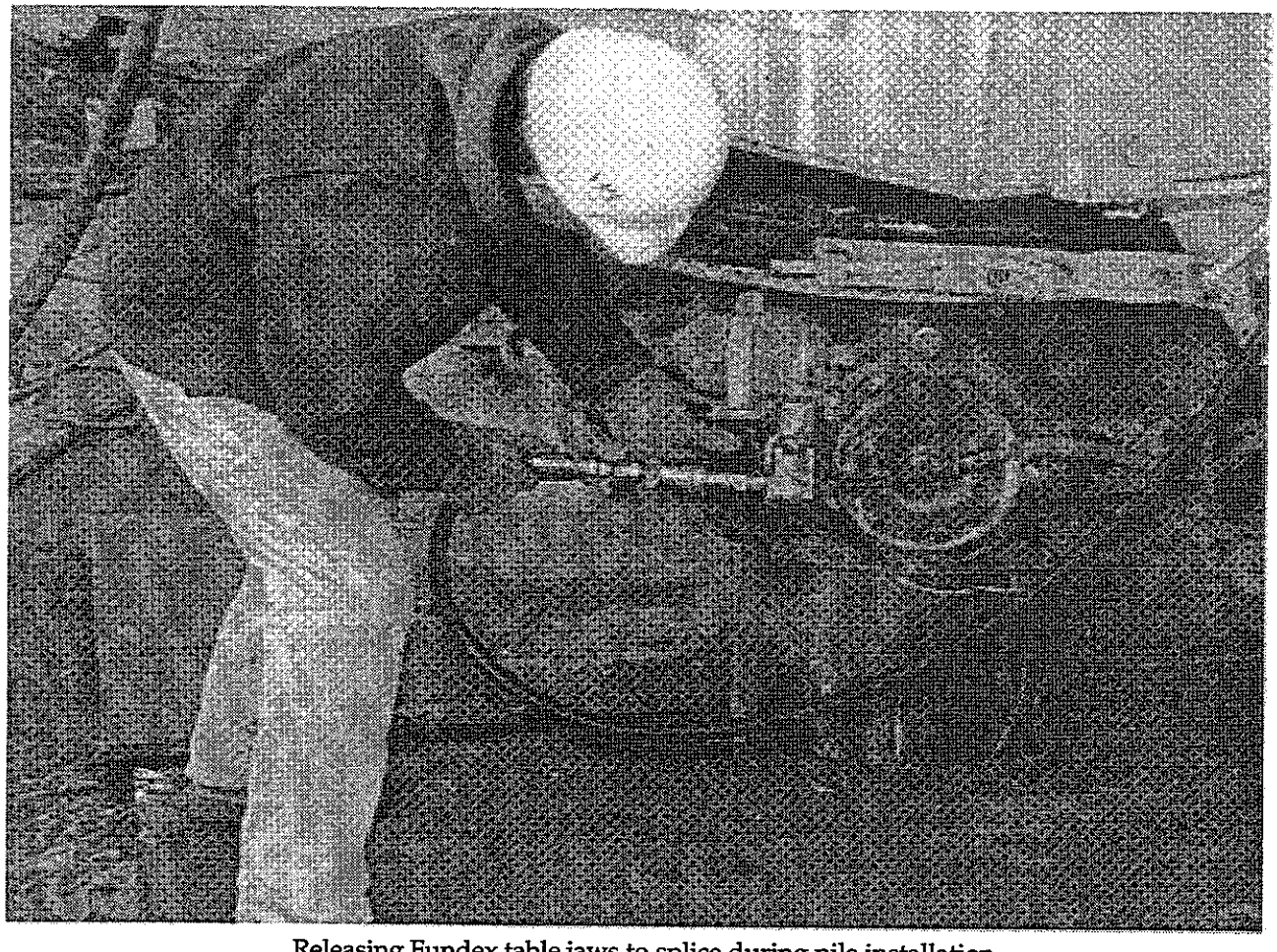
4. The contractor had estimated that this Fundex rig could install a 3.7 m (12 ft) section of pile with a 4.9 m (16 ft) vertical clearance, but a test revealed that the maximum section that could be installed is 2.7 m (9 ft). This would significantly increase installation times by increasing the number of pile segments, and therefore the number of pile splices. The increase in installation times is over the observed installation times during this project.

INDICATOR PILE TEST PROGRAM
FOR THE SEISMIC RETROFIT
OF THE EAST APPROACH STRUCTURE OF THE
SAN FRANCISCO - OAKLAND BAY BRIDGE
OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

Appendix A

Site Plans and Soil Profile



Releasing Fundex table jaws to splice during pile installation

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995

INDEX OF SHEETS

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	Ala	80	1.0/1.3	1	

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

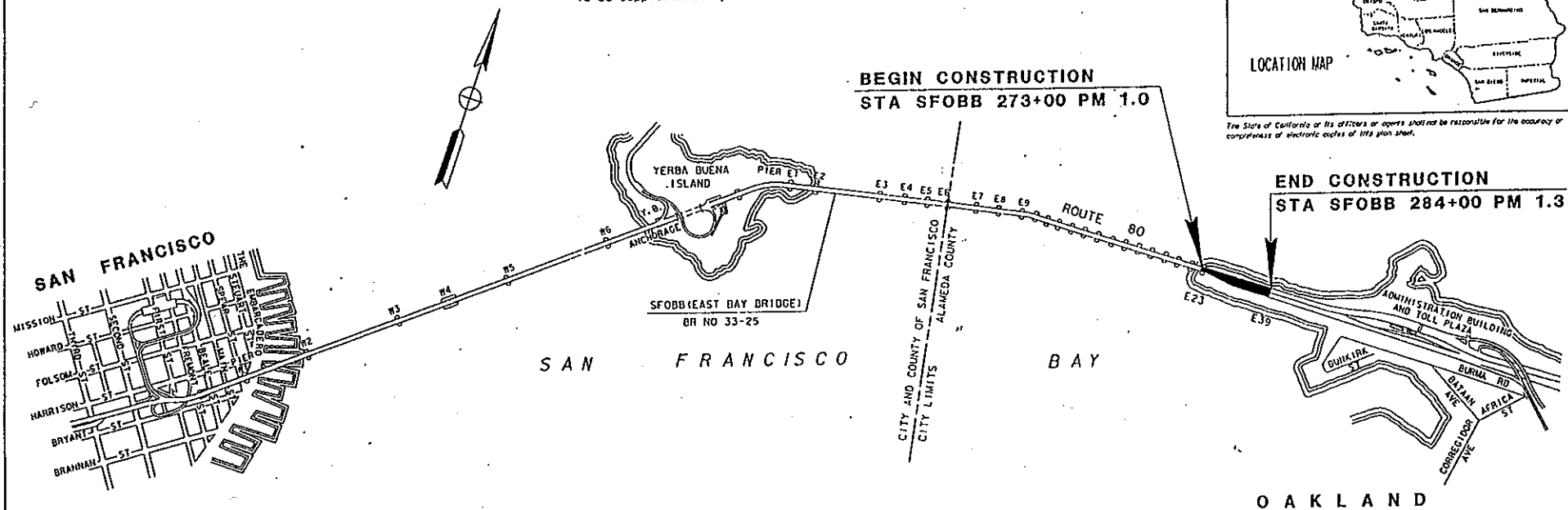
PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN ALAMEDA COUNTY IN OAKLAND ON THE SAN FRANCISCO - OAKLAND BAY BRIDGE

To be supplemented by Standard Plans dated July, 1992

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.



NO SCALE

Project Engineer 10-21-94
Registered Civil Engineer

REGISTERED PROFESSIONAL ENGINEER
A.J. Zepeda
No. 46376
Exp. 12-31-94
CIVIL
STATE OF CALIFORNIA

Plans Approval Date

PROJECT ENGINEER A.J. ZEPEDA
PROJECT MANAGER JUDY C. CHEN

The Contractor shall possess the Class (or classes) of license as specified in the "Notice to Contractors".

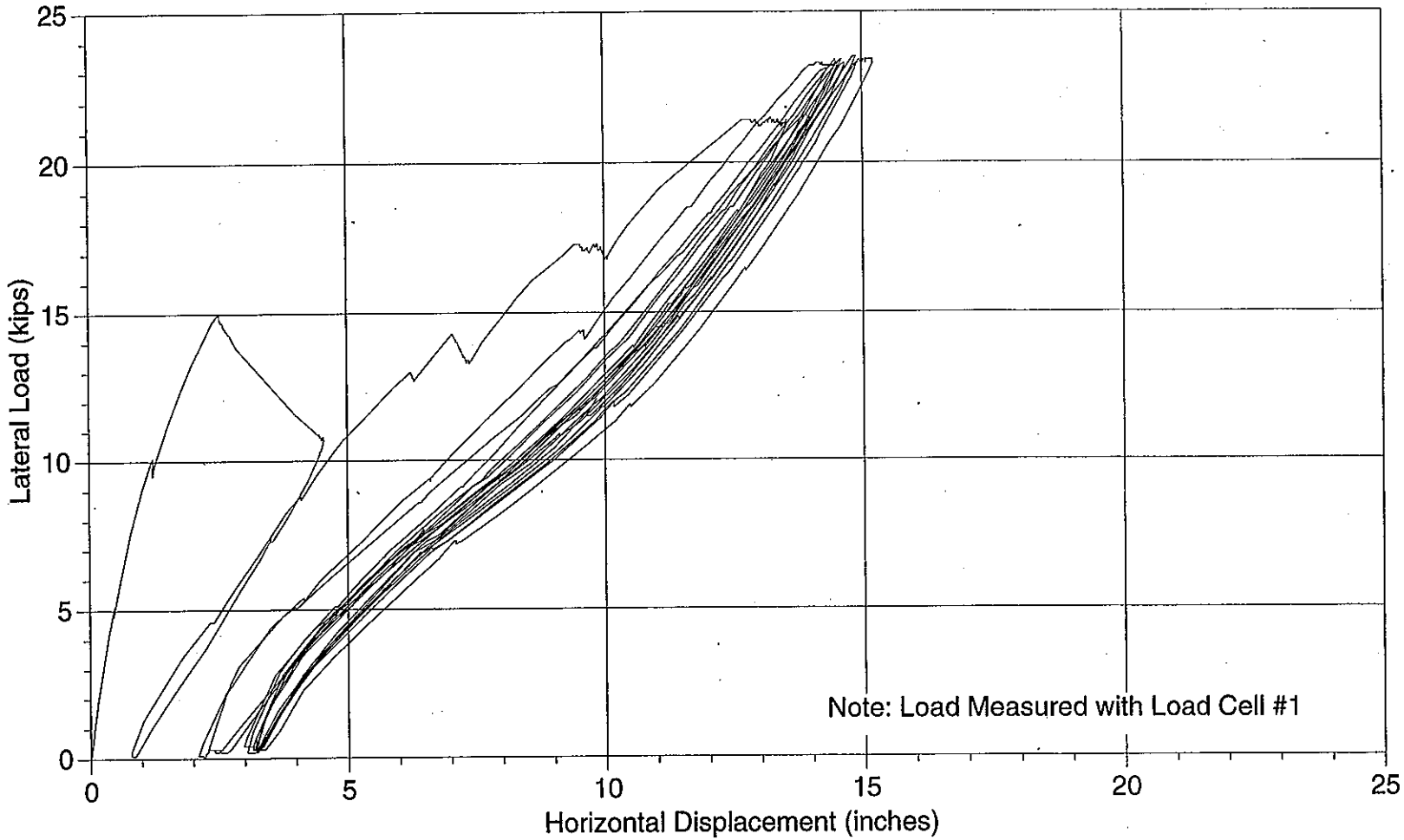
Service Contract No. 04-043494

FOR REDUCED PLANS ORIGINAL SCALE IS 10 INCHES

USERNAME => pwtif

CU 04249 | FA 043491

FORM OC-OE-93-PF (REV. 3/88)



Pile Type: Fundex PP 20x0.5 (-65' to -8.0') PP 20x0.75 (-8.0' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/9/94

Date Tested: 12/20/94

Installation Time: 7 hours 3 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

Pile Tip Elevation: -65.0 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.0 feet

Lateral Load - Displacement Near Pile Top

Test Site 3, Pile 4

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	ALA	80			

REGISTERED ENGINEER - CIVIL

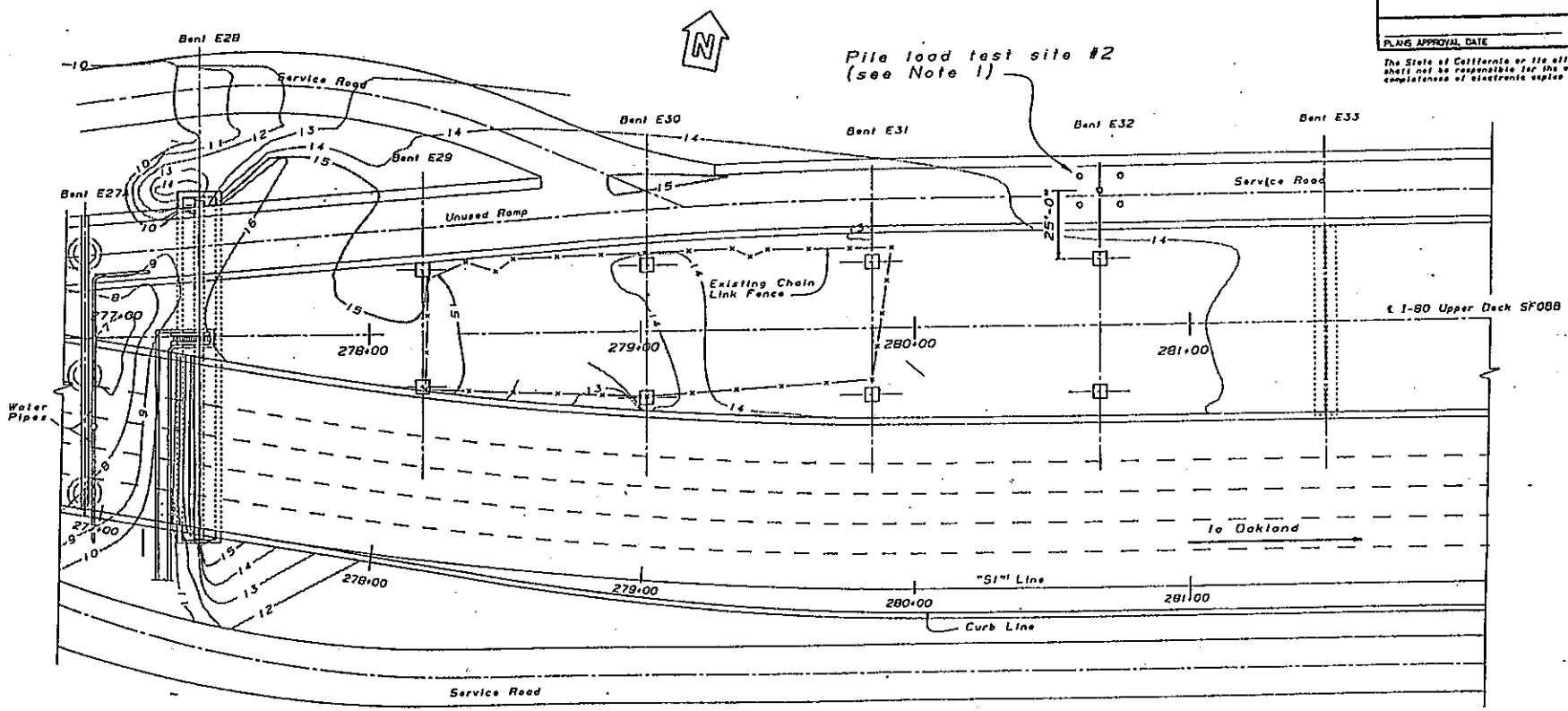
REGISTERED PROFESSIONAL ENGINEER Gregory Eom Sloan No. 44950 Exp. 3-31-95 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

NOTE:
THE CONTRACTOR SHALL VERIFY ALL CONTROLLING FIELD DIMENSIONS BEFORE ORDERING OR FABRICATING ANY MATERIAL.

Upper Deck not shown for clarity.



Notes:

1. For test pile layout and details, see Load Test Pile Details (1) and Load Test Pile Details (2) sheets.

PLAN
1" = 20'-0"

DESIGN	John Fujimoto	CHECKED	Shawn Sun
DETAILS	FD/AES 10-94	CHECKED	Shawn Sun
QUANTITIES	Ali Hamza	CHECKED	Lien Duan

DIMENSIONS, SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

SEISMIC RETROFIT PROJECT No. 614

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF STRUCTURES
STRUCTURE DESIGN 2

CU 04
EA ~~0431H~~

BRIDGE NO. 33-25
POST MILE 1.0-1.3

DISREGARD PRINTS DATED ~~PRIOR~~ FURTHER REVISION DATES → 10-12-94

SF08B - PILE LOAD TEST
BENT E29 TO E32
SITE PLAN 2

SHEET 4

DE 000 2138 (DACO 4/90)

DIST.	COUNTY	ROUTE	TOTAL PROJECT	NO.	SHEET
04	ALA	80			

REGISTERED ENGINEER - CIVIL

PLANS APPROVAL DATE

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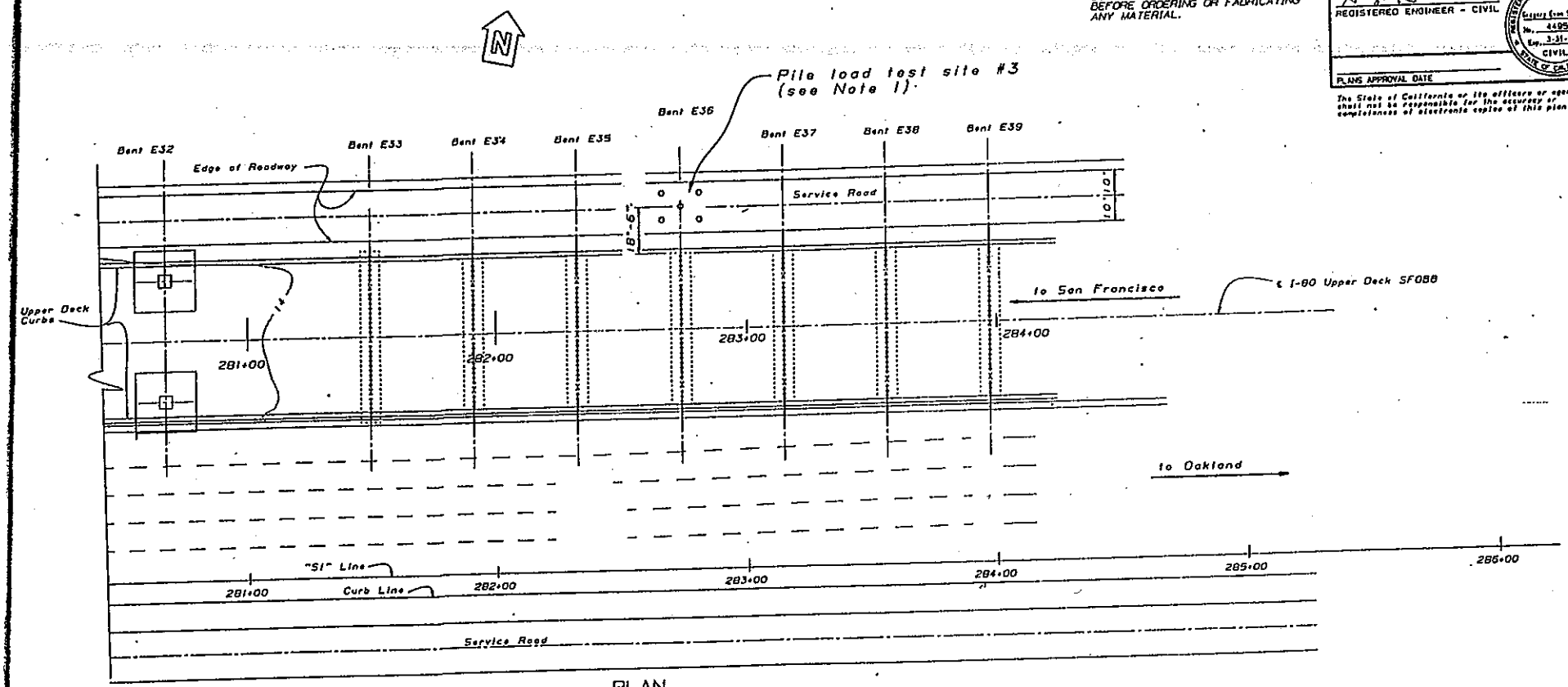
NOTE:
THE CONTRACTOR SHALL VERIFY ALL CONTROLLING FIELD DIMENSIONS BEFORE ORDERING OR FABRICATING ANY MATERIAL.



PLAN
1" = 20'-0"

Notes:

1. For test pile layout and details, see Load Test Pile Details (1) and Load Test Pile Details (2) sheets.

DESIGN	BY John Fujimoto	CHECKED Shawn Sun	
DETAILS	BY FIMAES 10-94	CHECKED Shawn Sun	
QUANTITIES	BY Hisam Akkad	CHECKED Simon Blank	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

SEISMIC RETROFIT PROJECT No. 614

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF STRUCTURES
STRUCTURE DESIGN 2

BRIDGE NO. 33-25
POST MILE 1.0-1.3

CU 04
EA ~~043436~~

SFOBB - PILE LOAD TEST
BENT E33 TO E39
SITE PLAN 3

OTHERWISE PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 10-12-94

SHEET 5

DS DOD 2130 (CADD 4/90)

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOT SHEE
04	Ala	80			

REGISTERED ENGINEER - CIVIL

REGISTERED PROFESSIONAL ENGINEER Gregory Evan Slocum No. 44950 Exp. 3-31-98 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

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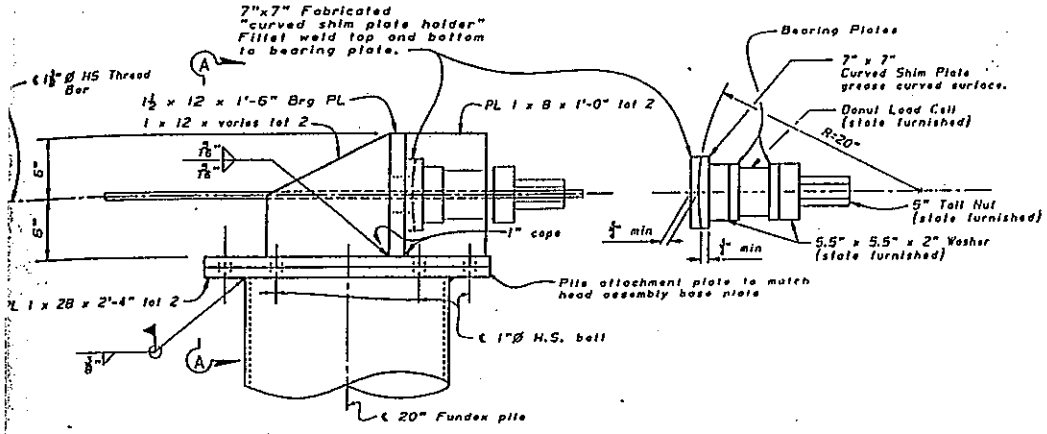
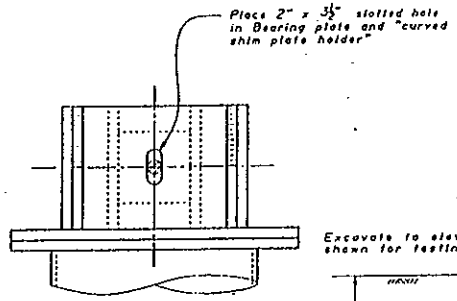


BRACKET ELEVATION

2" = 1'-0"

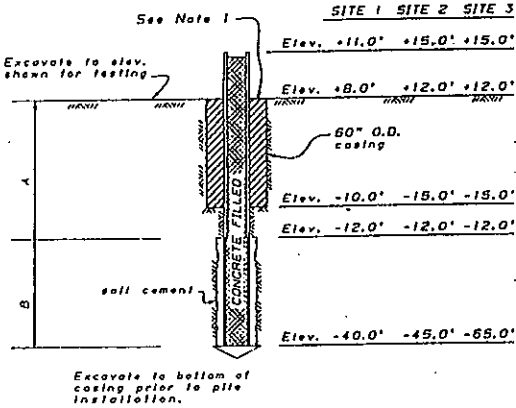


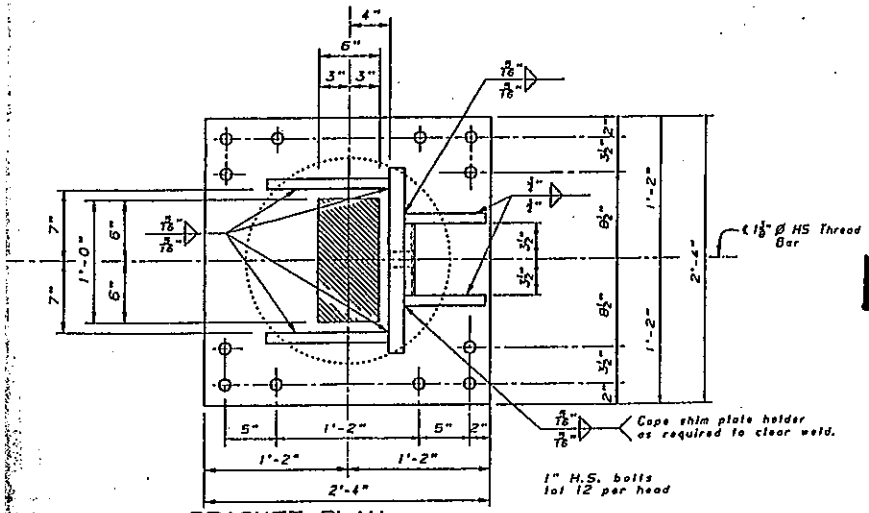
VIEW A-A

2" = 1'-0"

TEST PILE LOCATION				
		P1 & P2	P3 & P4	P5
TEST PILE WALL THICKNESS	A	½"	¾"	¾"
	B	½"	½"	½"

TEST LOCATION see Notes

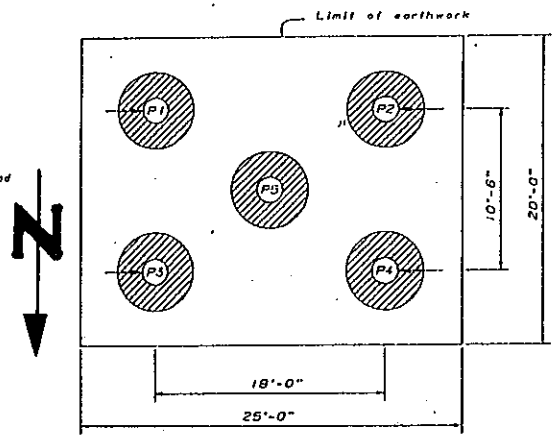




BRACKET PLAN

2" = 1'-0"

Indicates area of plates to be removed for instrumentation.



SITE PLAN FOR LOAD TEST SITES 1 - 3

Test Sequence:

1. Place lateral head assemblies on piles P1 - P4.
2. Laterally load piles P1 & P2.
3. Laterally load piles P3 & P4.
4. Remove lateral head assemblies from piles P1 through P4 and prep windows for vertical load tests in piles P1 through P5.
5. Compression load test pile P5.
6. Tension load test pile P5.

Note:

1. Cased shafts shall be filled with 90-95 lb/ft³ drilli mud during pile load test.
2. For test site location, see "Site Plan 1, Site Plan 2 and Site Plan 3" sheets.
3. Performance test pile shall be installed in same manner as production piles located in low overhead clearance areas. (Installation time, use of bentonite, etc.)
4. Each pile shall have a slope inclinometer casing placed within it before concrete is poured.

DESIGN	BY Bob Bateman	CHECKED Gregory Slocum	
DETAILS	BY FB/AES 10-94	CHECKED Bob Bateman	
QUANTITIES	BY Bob Bateman	CHECKED Simon Blank	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

SEISMIC RETROFIT PROJECT No. 614

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

DIVISION OF STRUCTURES STRUCTURE DESIGN 2

CU 04
EA 04343K

BRIDGE NO. 33-25
POST MILE 1.0-1.3

SFOBB - PILE LOAD TEST

BENT E23 TO E39

LOAD TEST PILE DETAILS (2)

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 10-11-94 10-21-94 10/28/94

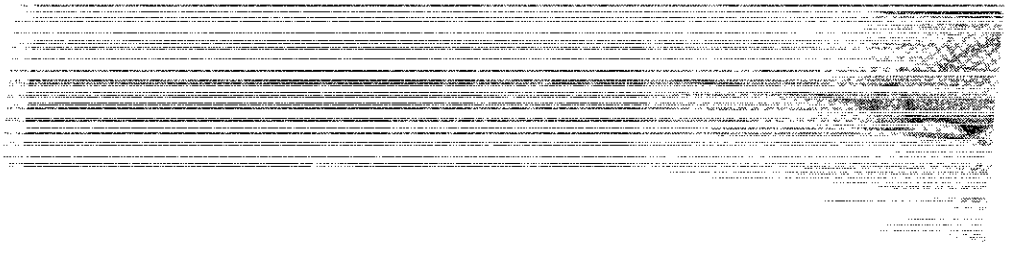
SHEET 7 2

INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

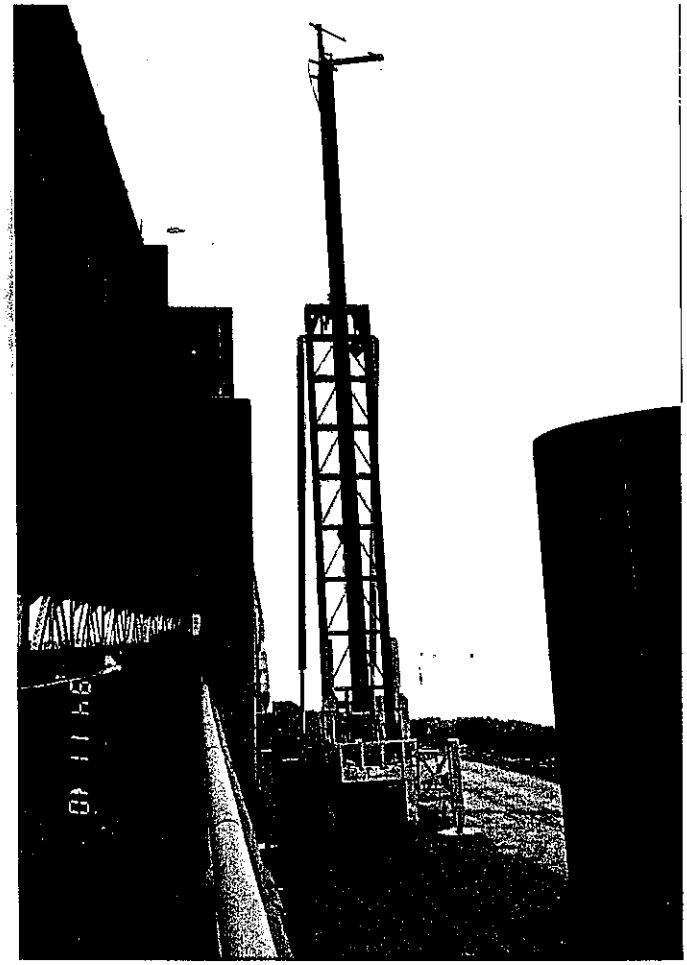
Appendix B

Project Photographs and Diagrams



Drilling between the casing and the pile to the bottom of the casing with a small core barrel

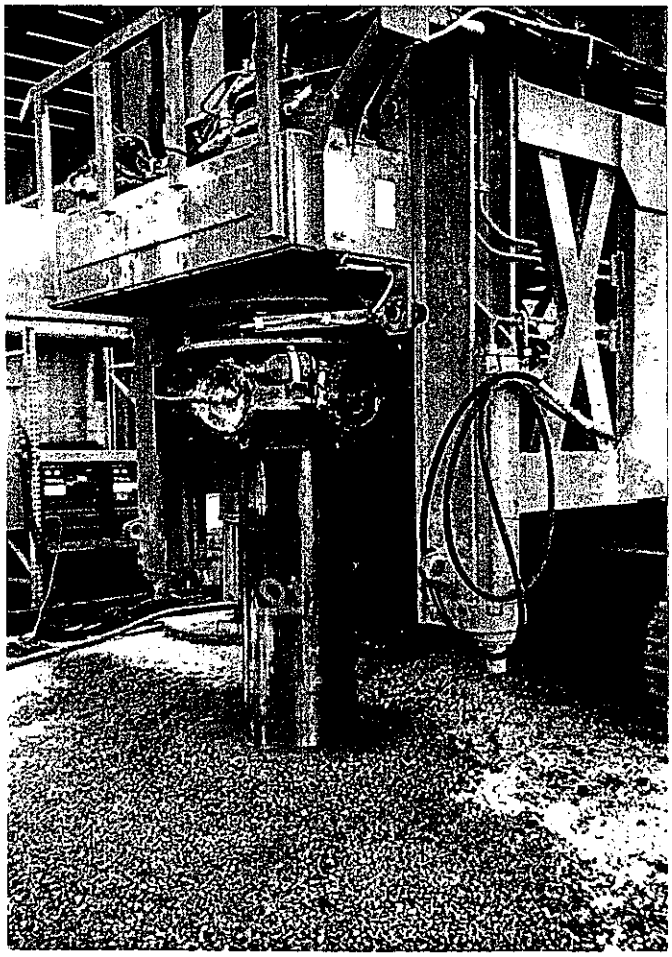
Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995



Photograph No. 1

Fundex Rig

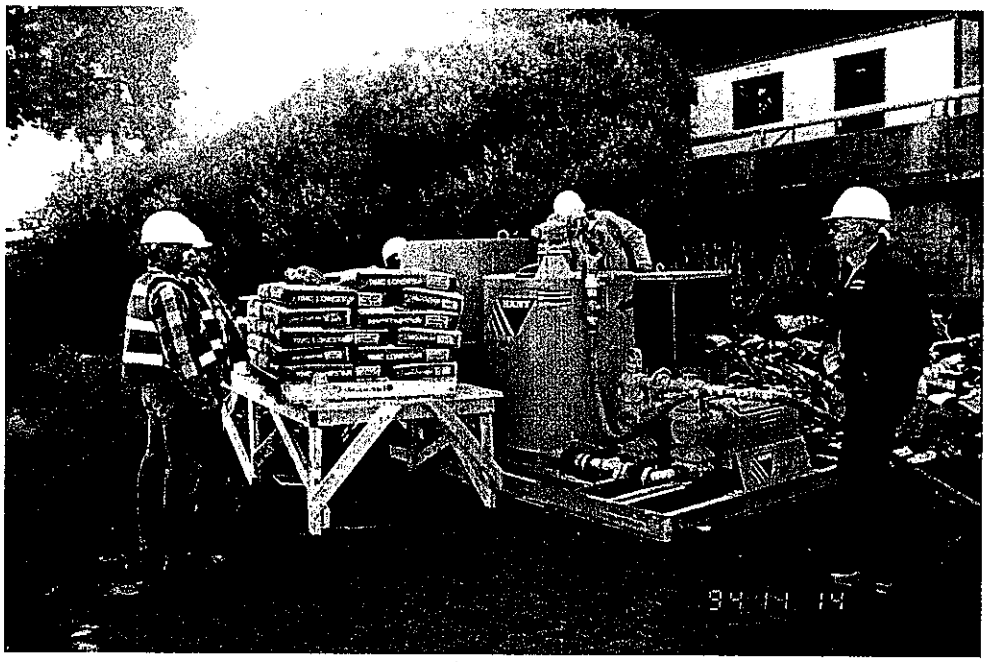
Full Mast 12+ m (40+ ft) and 5.8 m (19 ft)
Drill Table Hydraulic Rams (Yellow)



Photograph No. 2

Pile Installation

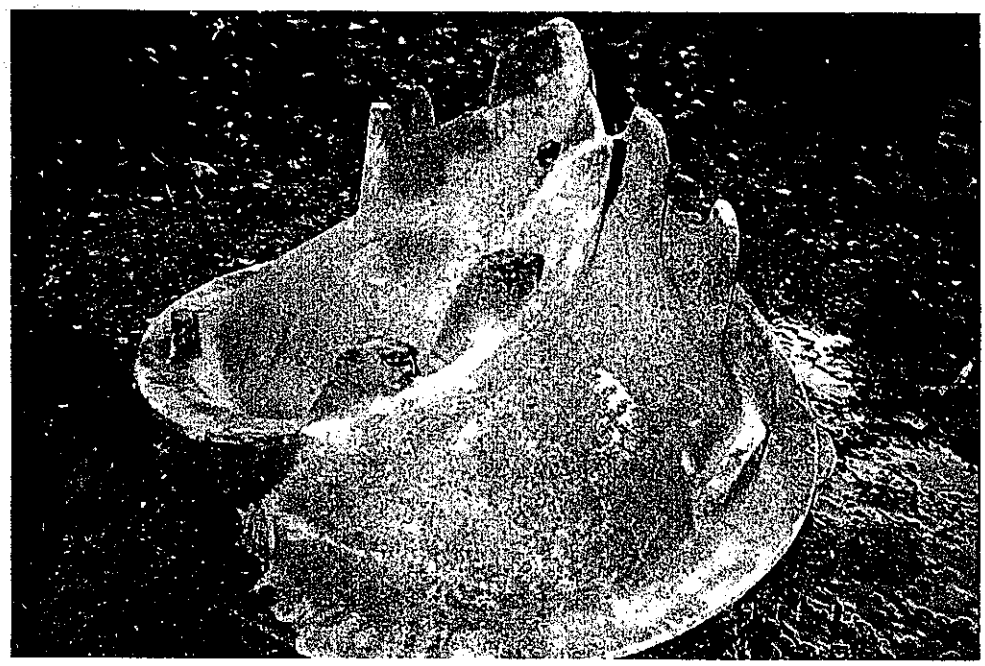
Installing sample pile at Site 1



Photograph No. 3

Grout Plant

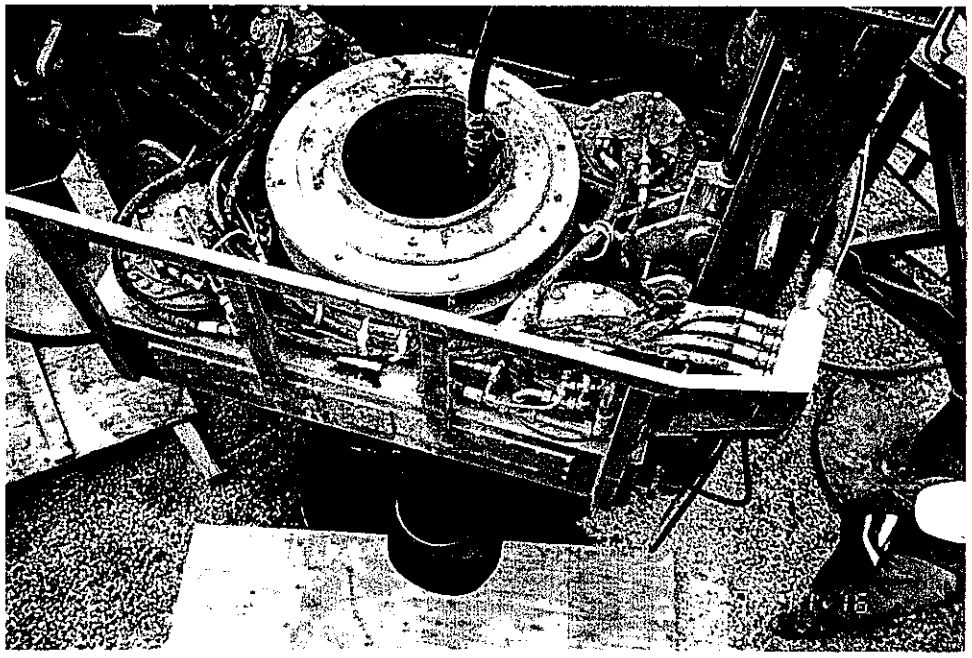
Left to Right - Mixing Tank, Holding Tank (with stirring paddles),
2 Positive Displacement Pumps



Photograph No. 4

Drill Point

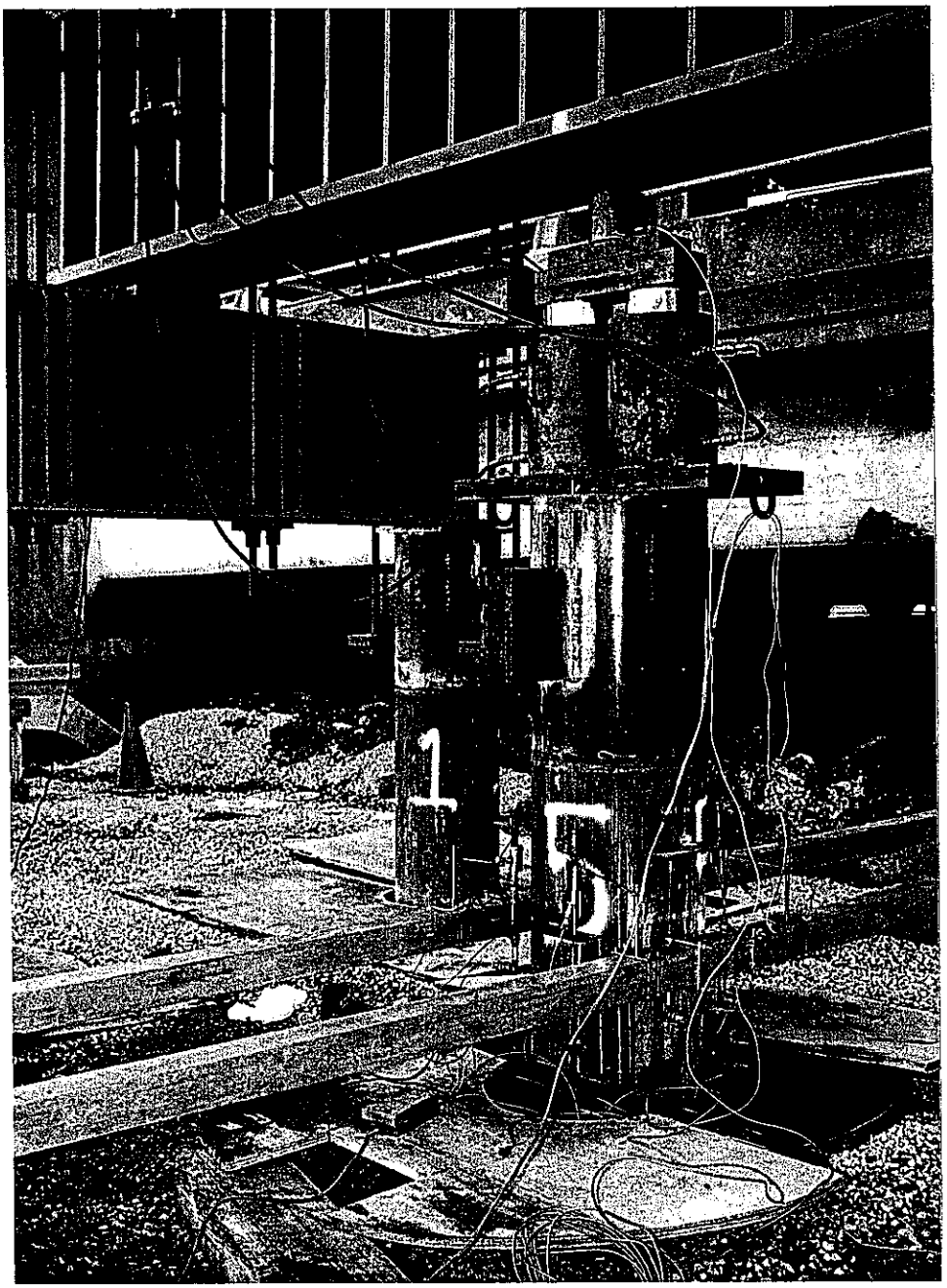
Note hole (other holes hidden) for grout ejection



Photograph No. 5

Drill Table

Note grout pipe inside of pipe pile (in center of table)



Photograph No. 6

Compression Test

Detail of Site 1, Pile 5, Static Axial Compression Test.

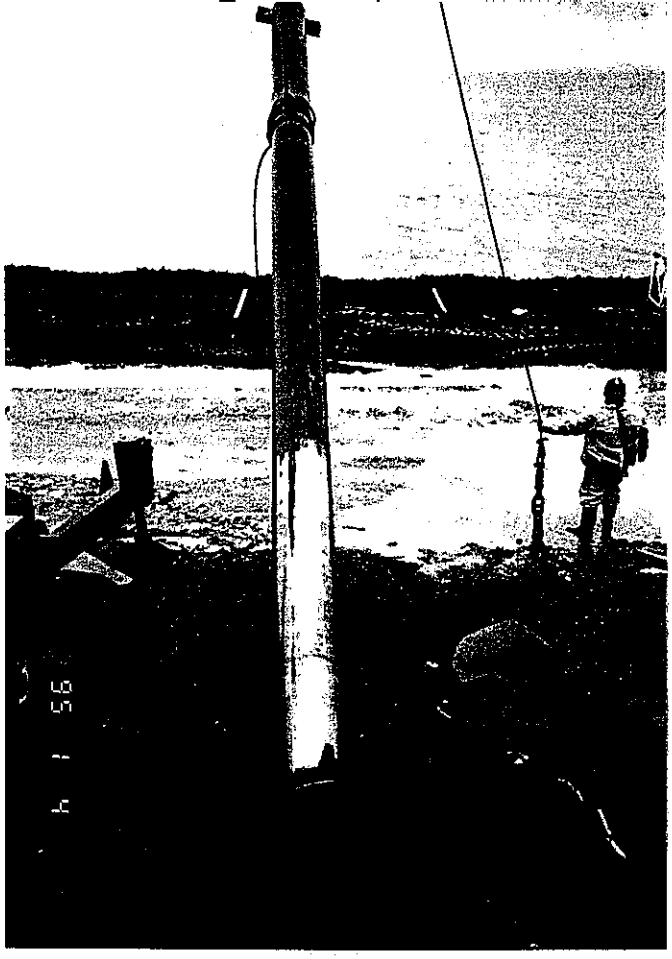
Primary System includes 4 Electronic Displacement Gauges and a 4,450 kN (1,000 kip) Electronic Load Cell which are all read every 15 seconds by a data acquisition system.

Secondary System includes 4 Electronic Displacement Gauges and a 4,450 kN (1,000 kip) Electronic Pressure Cell which are all hand recorded from displays.

Photograph No. 7

Abandoning Piles

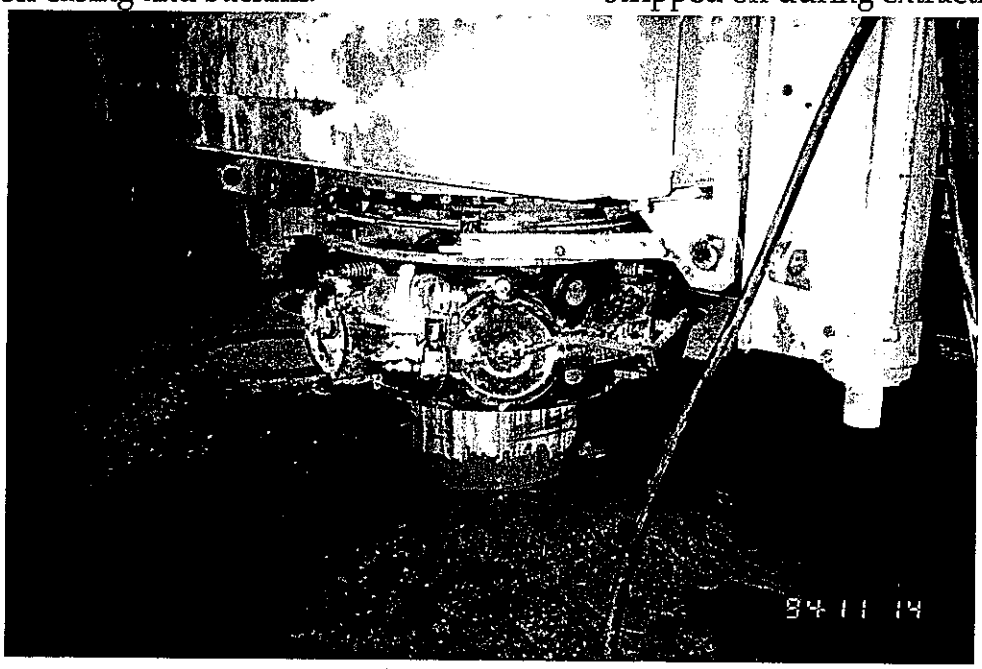
Chipping down piles below grade.
Will cut off casing and backfill.



Photograph No. 8

Pile Extraction

Site 1, Pile 5 extracted pile. Grout was stripped off during extraction



Photograph No. 9

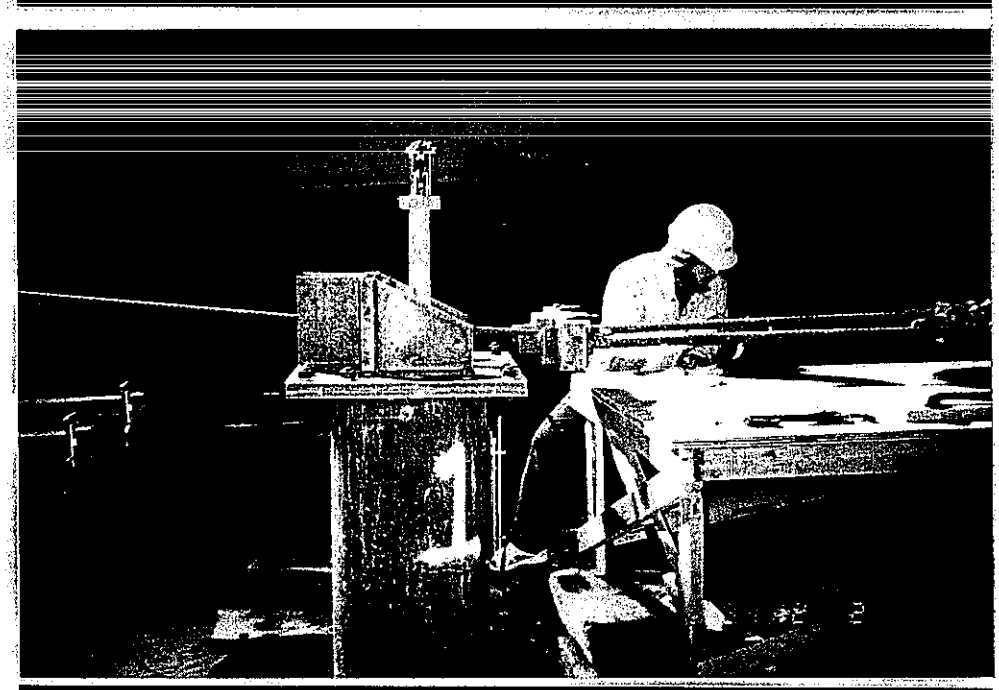
Sample Pile

Site 1, Sample Pile at 40 ft penetration.
Note grout bubbling to surface on the right side.

Photograph No. 10

Drilling Out Grout

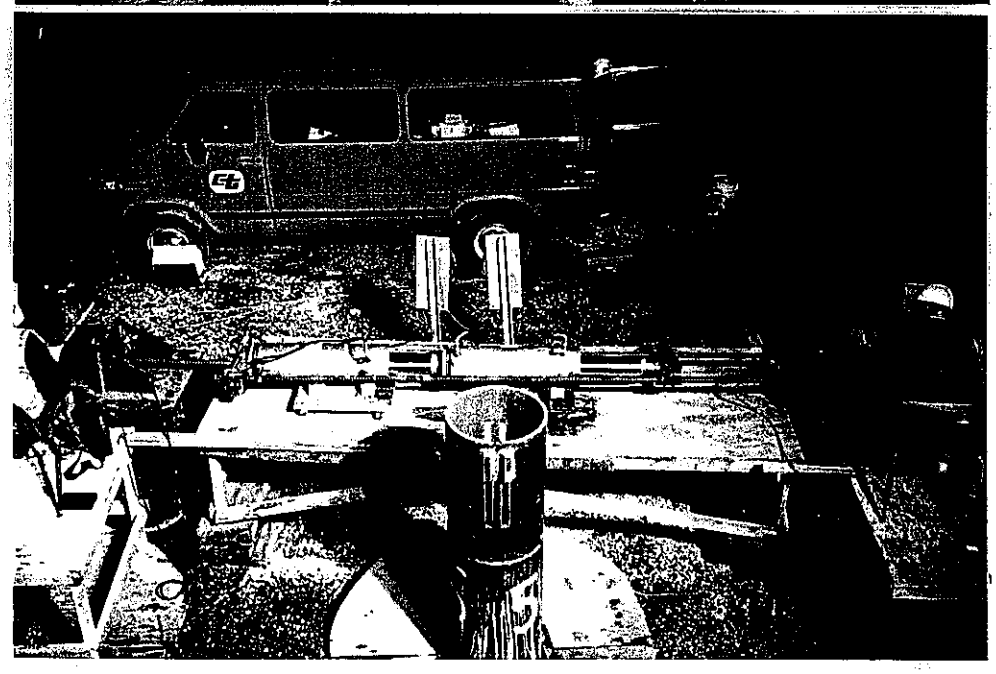
and mud between the casing and the pile at Site 2



Photograph No. 11

Lateral Load Test

Reading the Slope Inclinometer casings during a test. Note wire line transducers (blue boxes) left of Pile 1, with their wires attached to the pile 1.

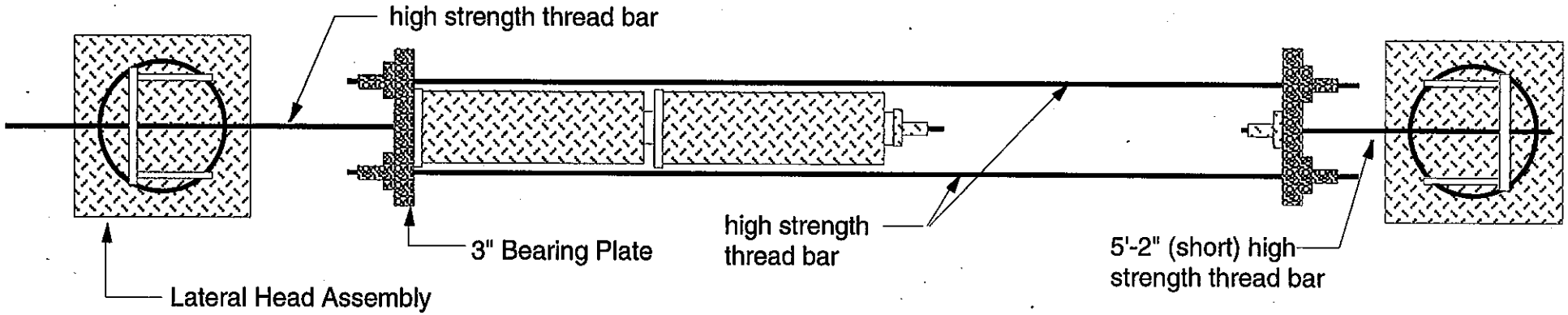


Photograph No. 12

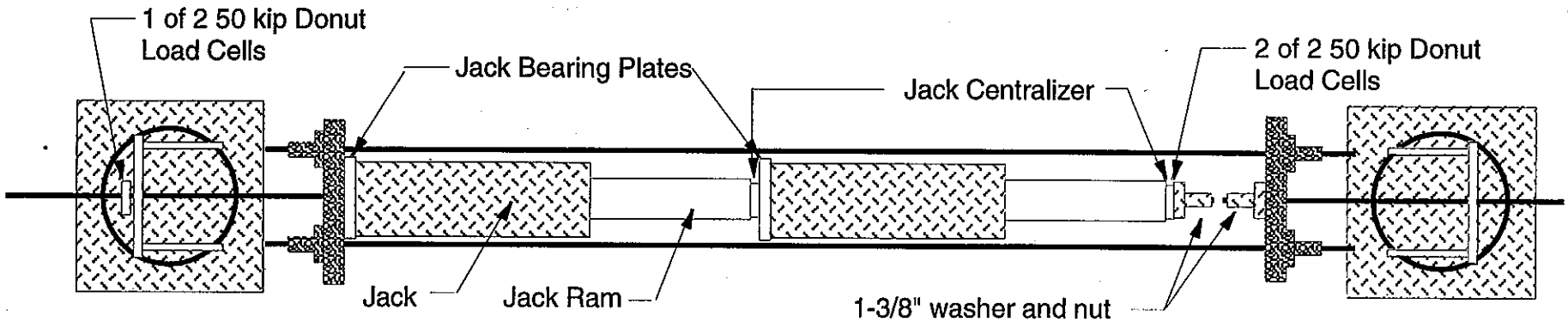
Lateral Load Test

Testing into the night at Site 1. Note Technicians on the left and right reading the Slope Inclinometers. Center pull jacks are almost fully extended.

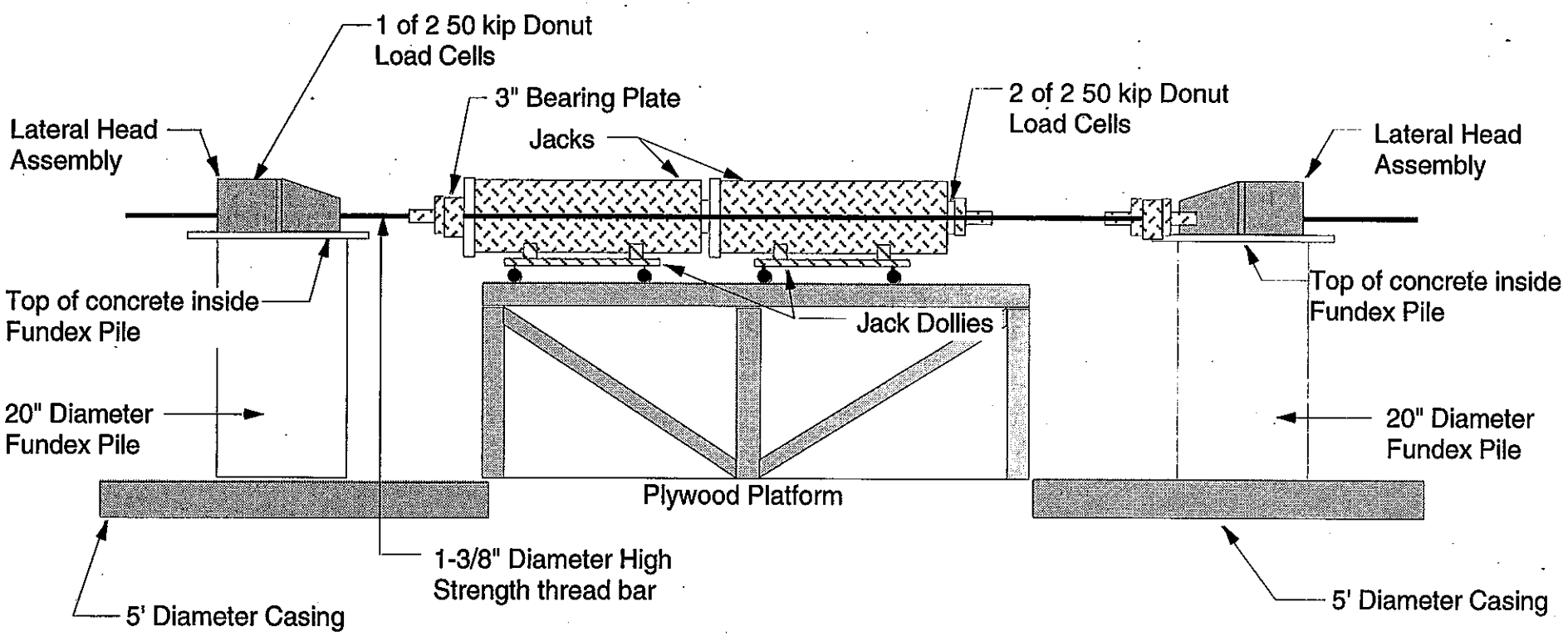
Before Jacking Plan View



After Jacking Plan View



Profile View

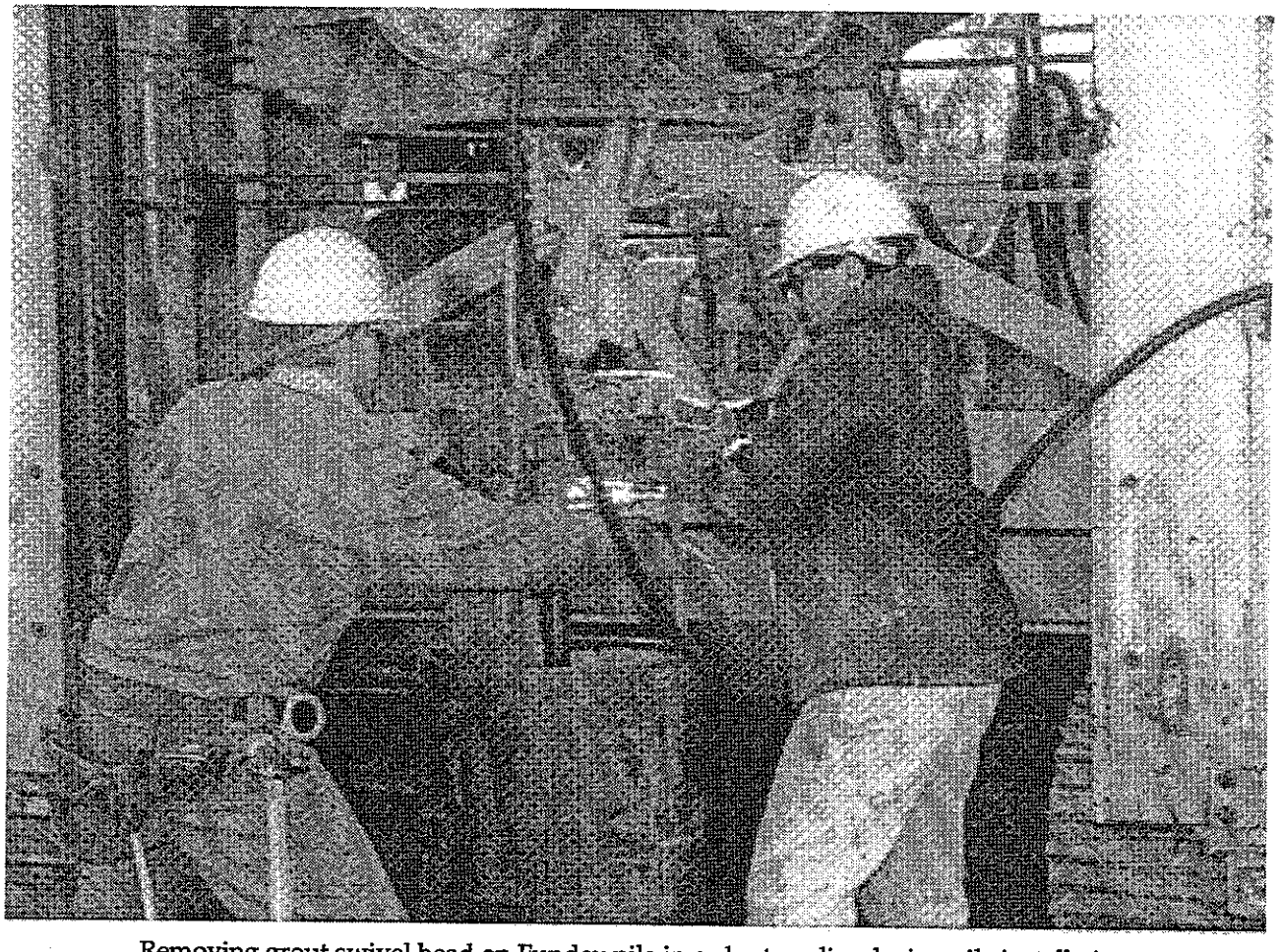


INDICATOR PILE TEST PROGRAM
FOR THE SEISMIC RETROFIT
OF THE EAST APPROACH STRUCTURE OF THE
SAN FRANCISCO - OAKLAND BAY BRIDGE
OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

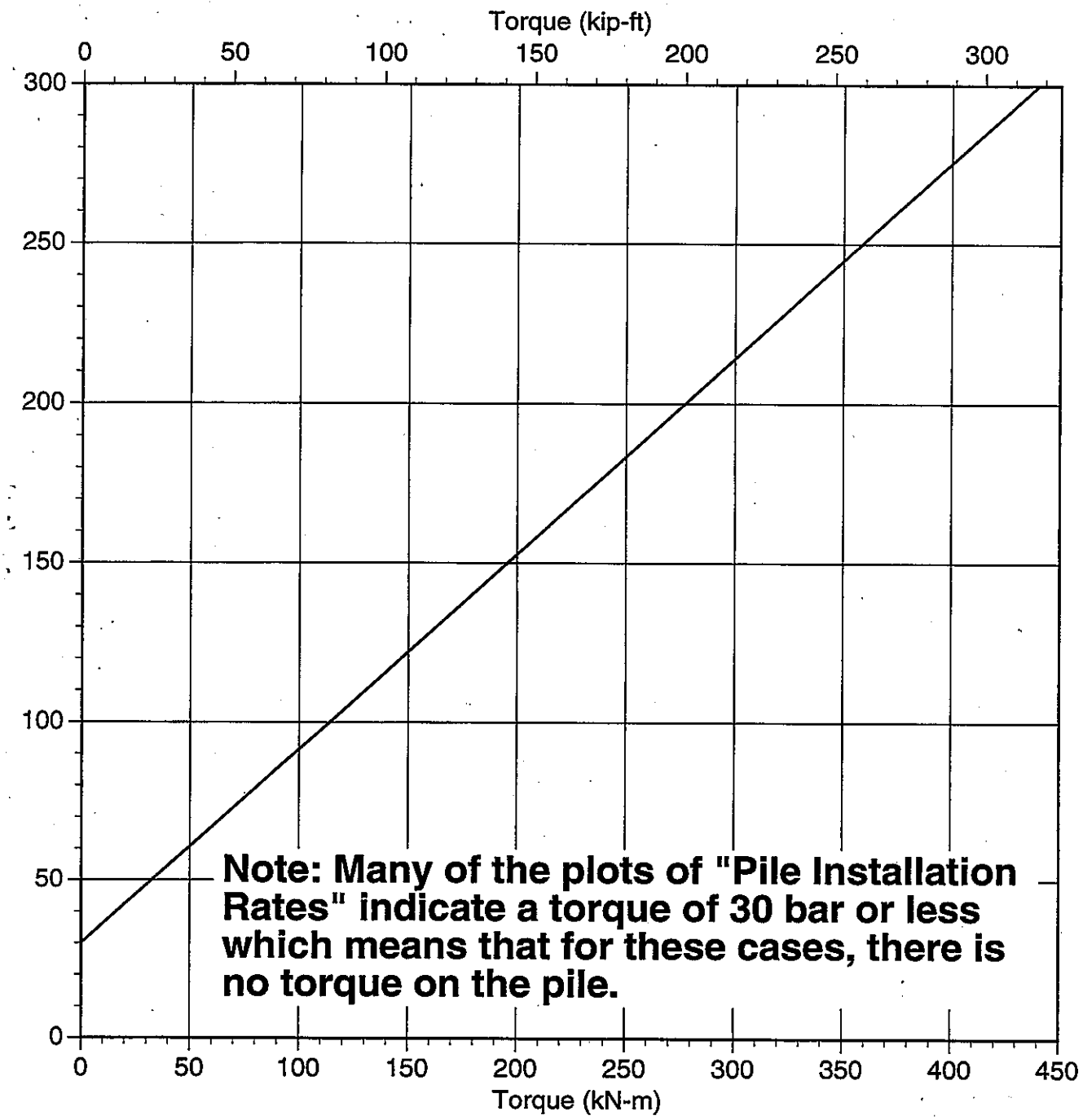
Appendix C

Fundex Pile Installation Records



Removing grout swivel head on Fundex pile in order to splice during pile installation

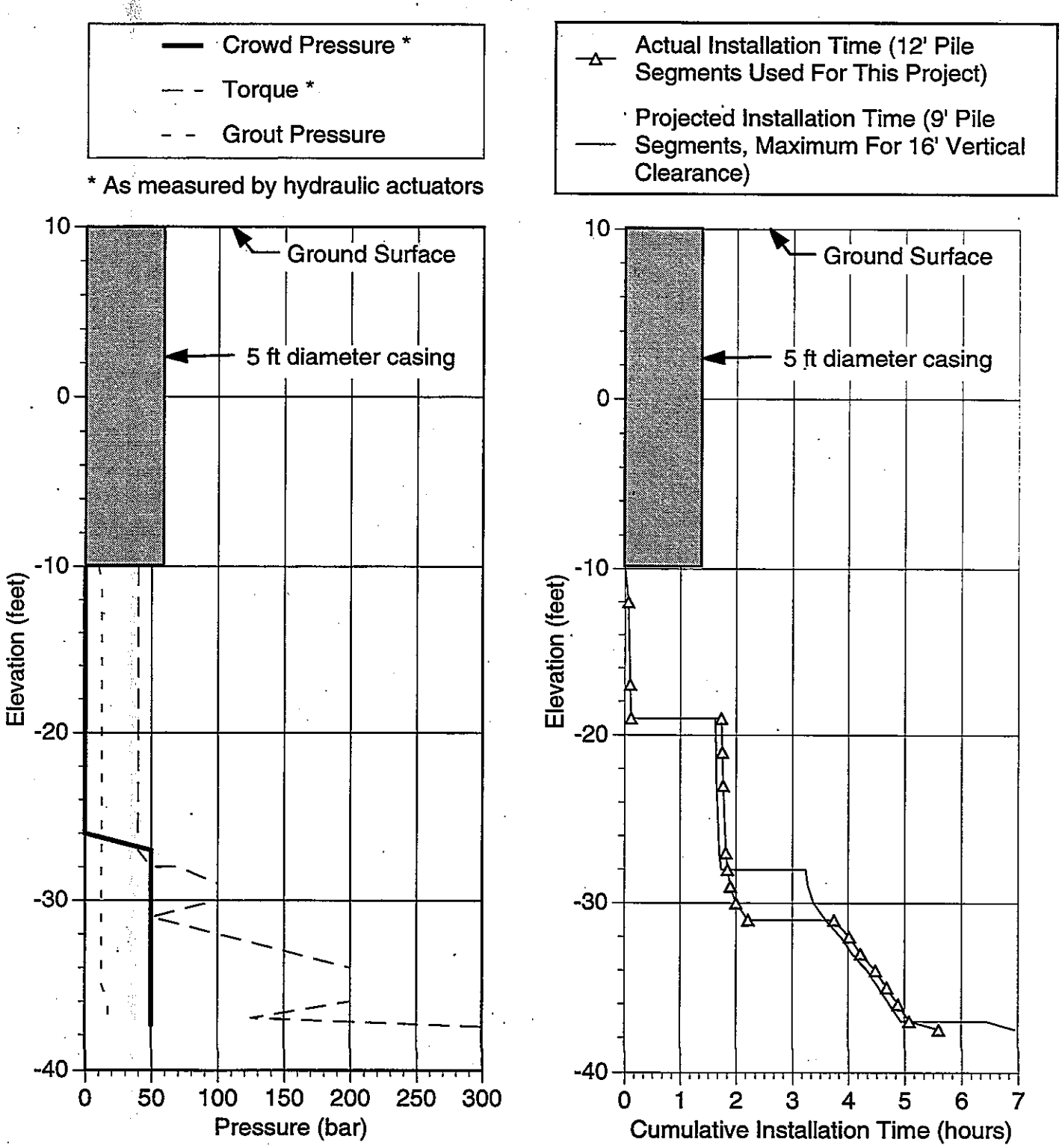
Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995



Fundex Drill Table Torque Graph
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program

04-Ala-80-1.0/1.3 04-043493 Bridge No. 33-25

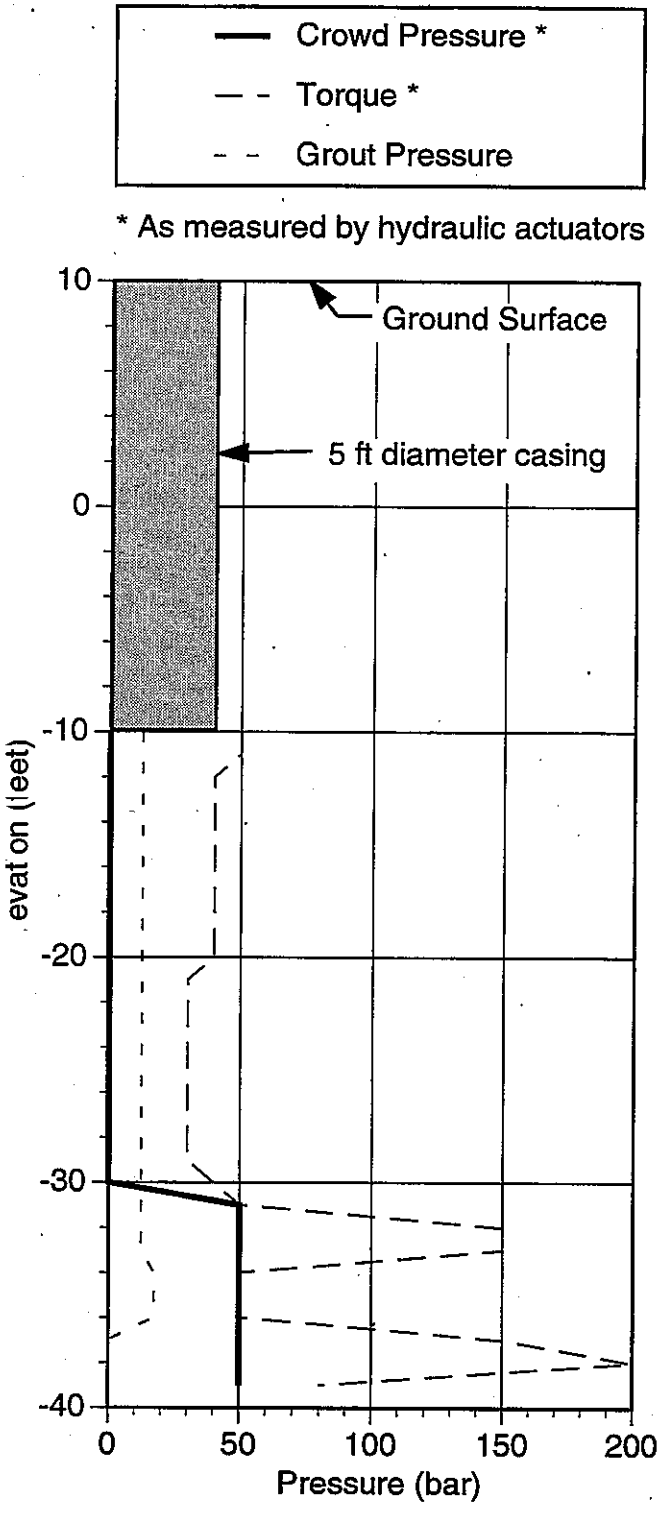
1 bar = 14.5 psi
1 kN-m = 0.723 kip-ft

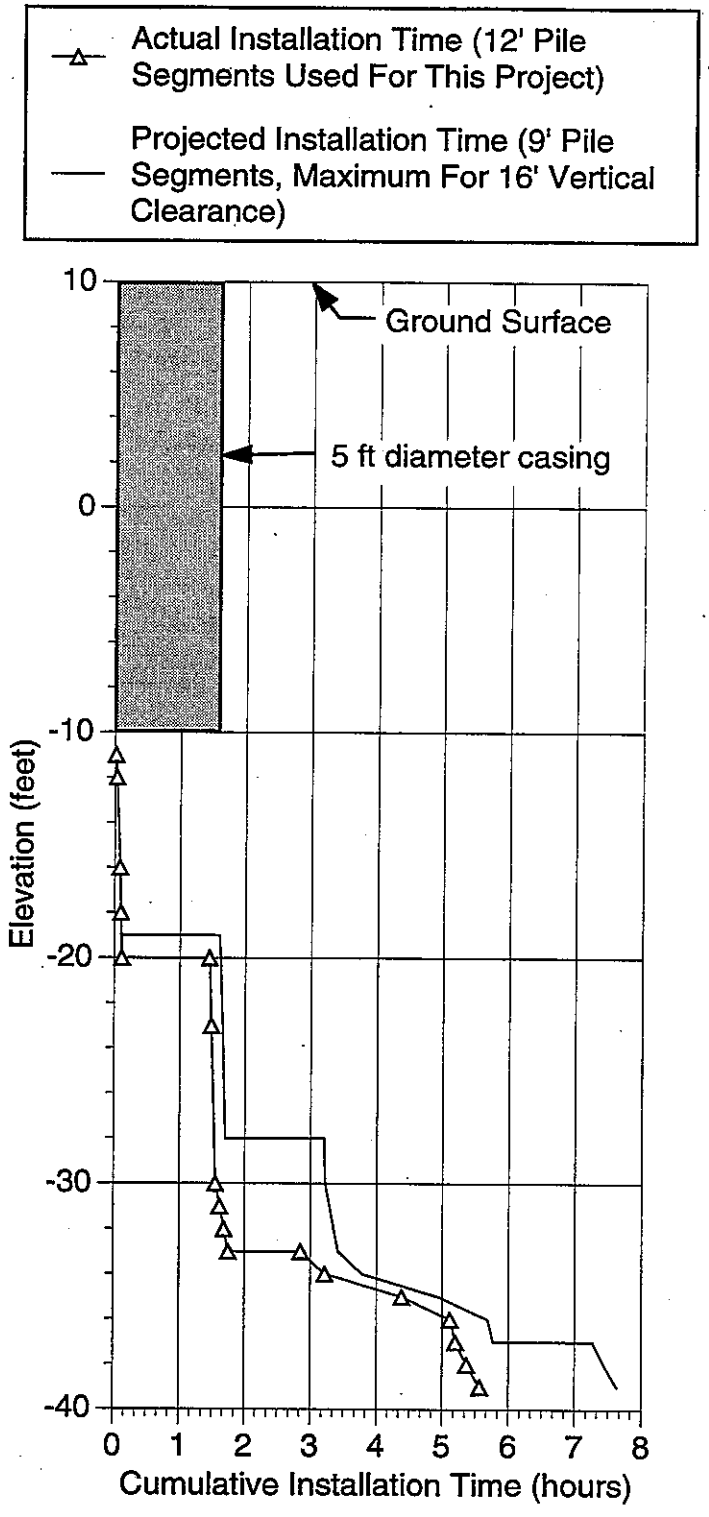


Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 1

Installation Date 11/16/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -10 ft
Total Installation Time 5 hrs 38 min

04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -37.5 ft, Spec Tip El. -40 ft
Projected Installation Time 6 hrs 57 min

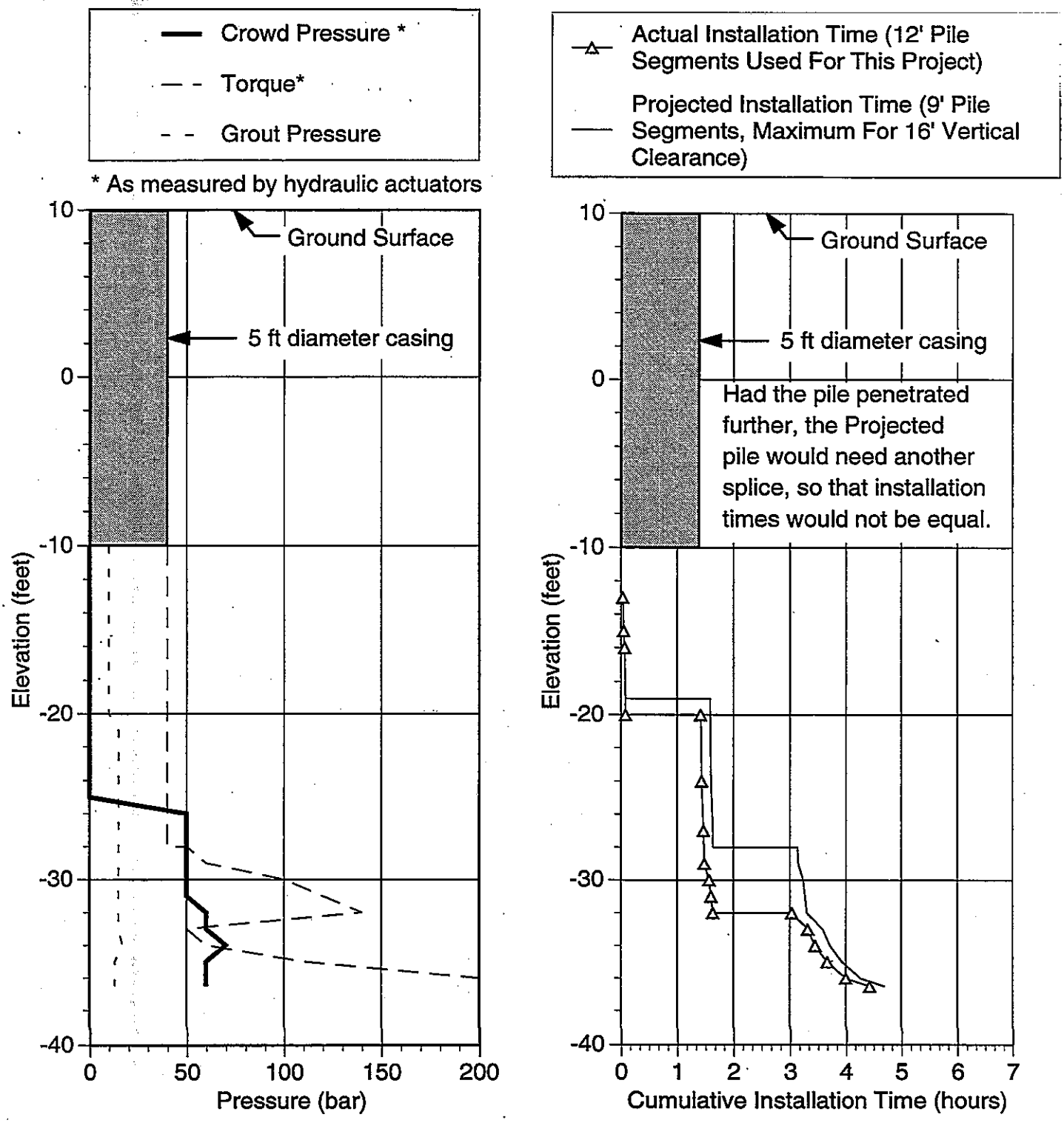




Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 2

Installation Date 11/17/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -10 ft
Total Installation Time 5 hrs 36 min

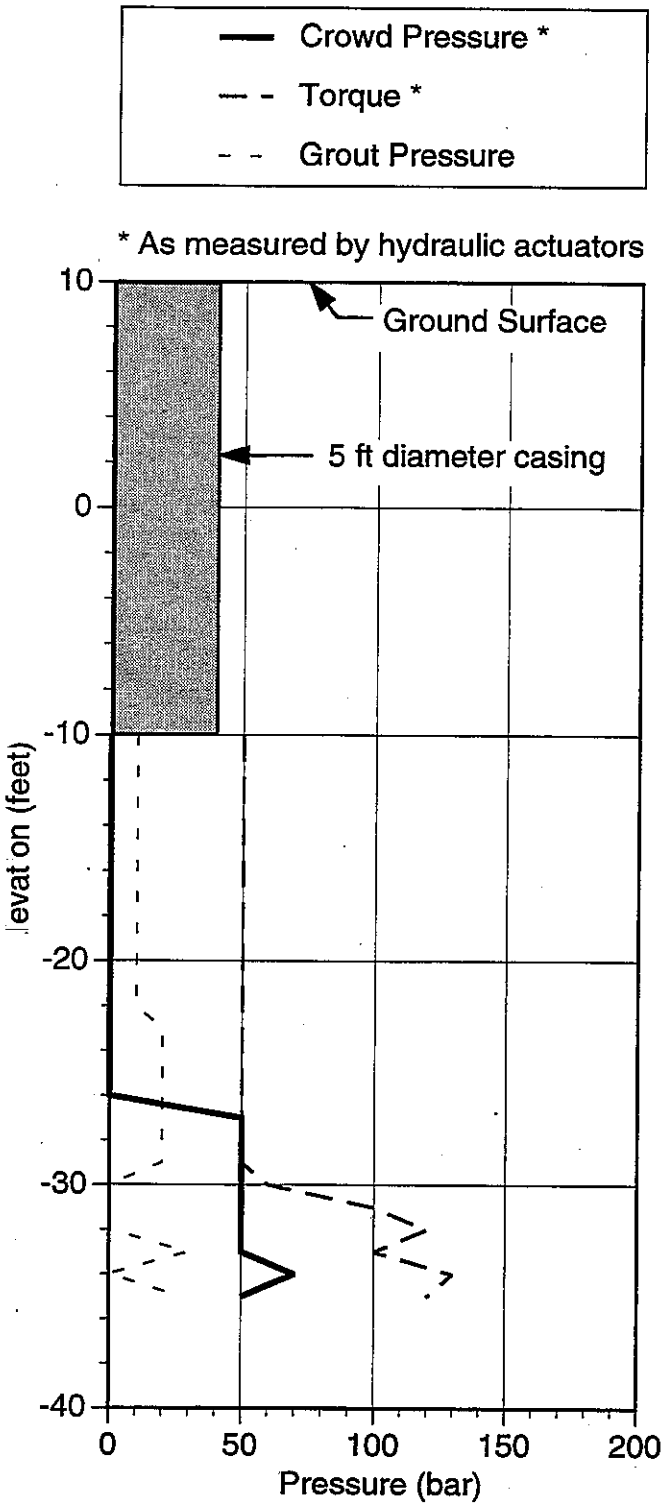
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -39.0 ft, Spec Tip El. -40 ft
Projected Installation Time 7 hrs 38 min

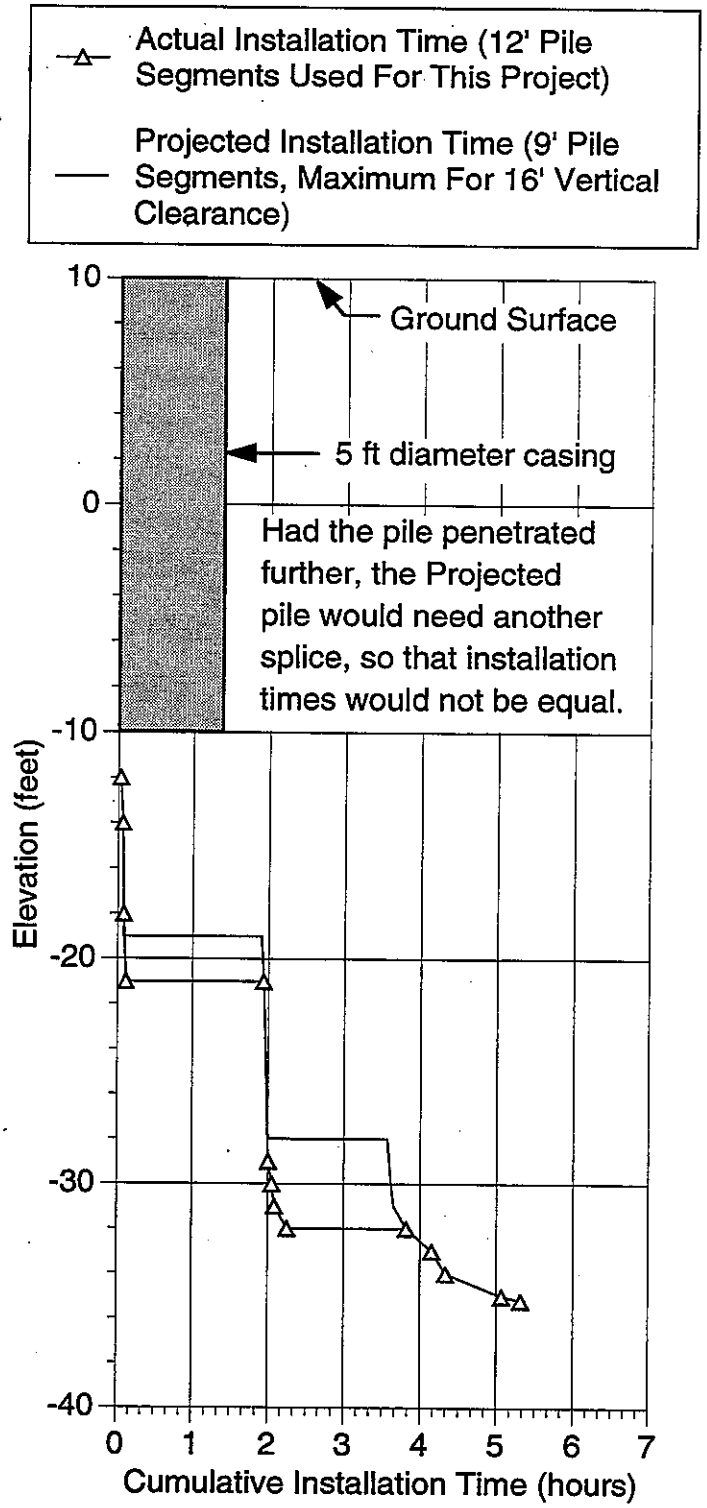


Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 3

Installation Date 11/21/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -10 ft
Total Installation Time 4 hrs 27 min

04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -36.5 ft, Spec Tip El. -40 ft
Projected Installation Time 4 hrs 42 min

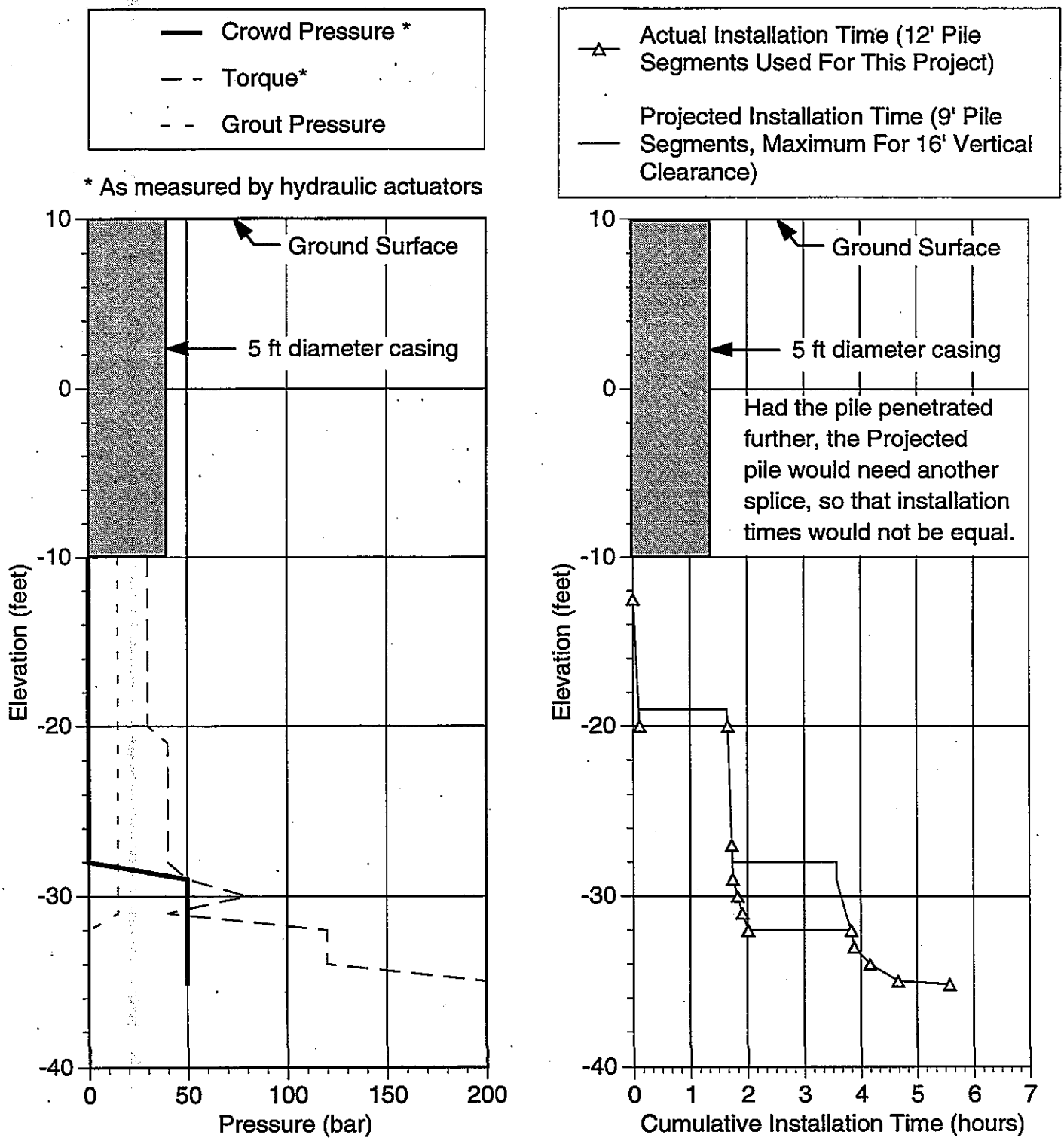




Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 4

Installation Date 11/21/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -10 ft
Total Installation Time 5 hrs 19 min

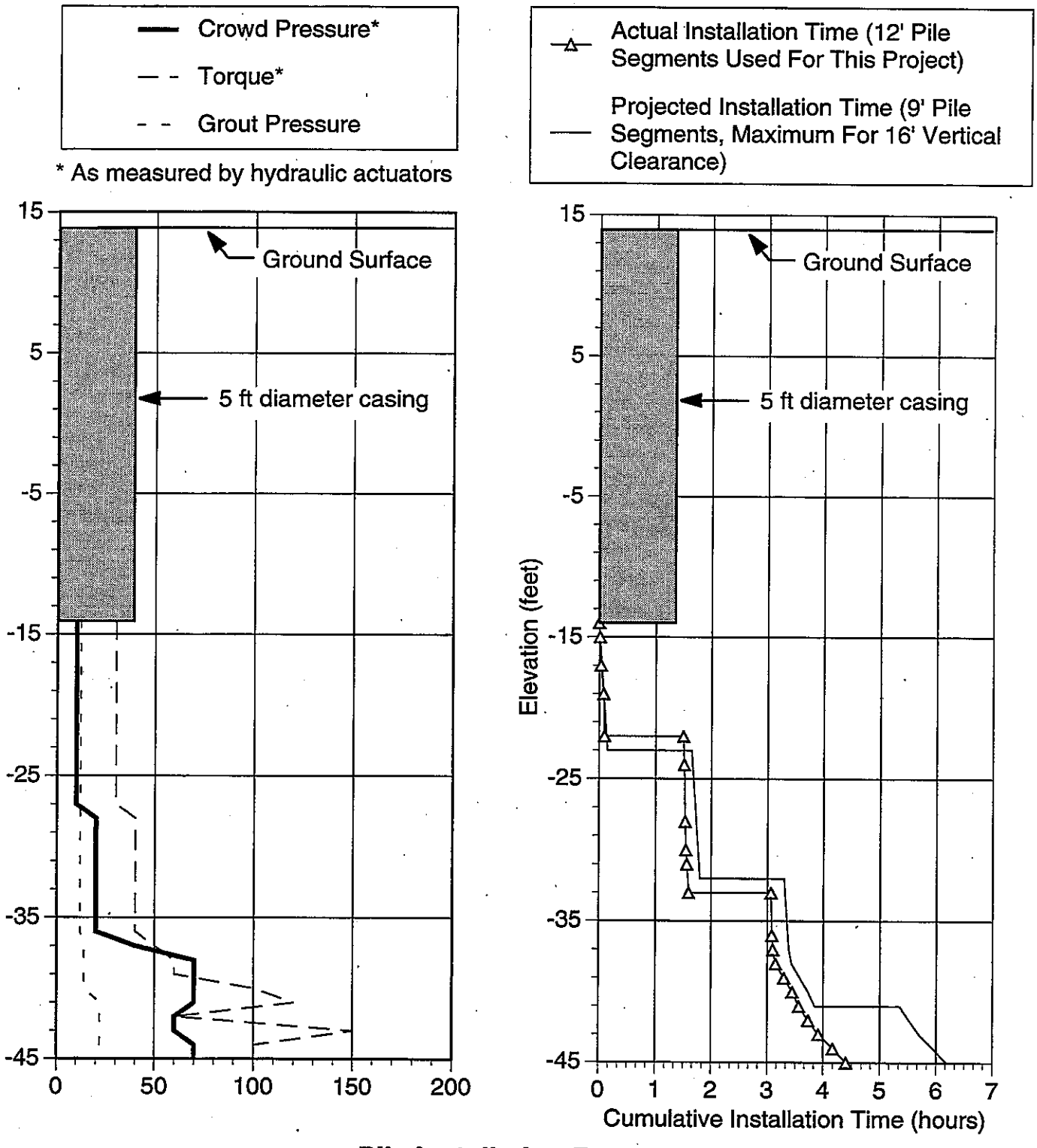
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -35.2 ft, Spec Tip El. -40 ft
Projected Installation Time 5 hrs 19 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 5

Installation Date 11/18/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -10 ft
Total Installation Time 5 hrs 35 min

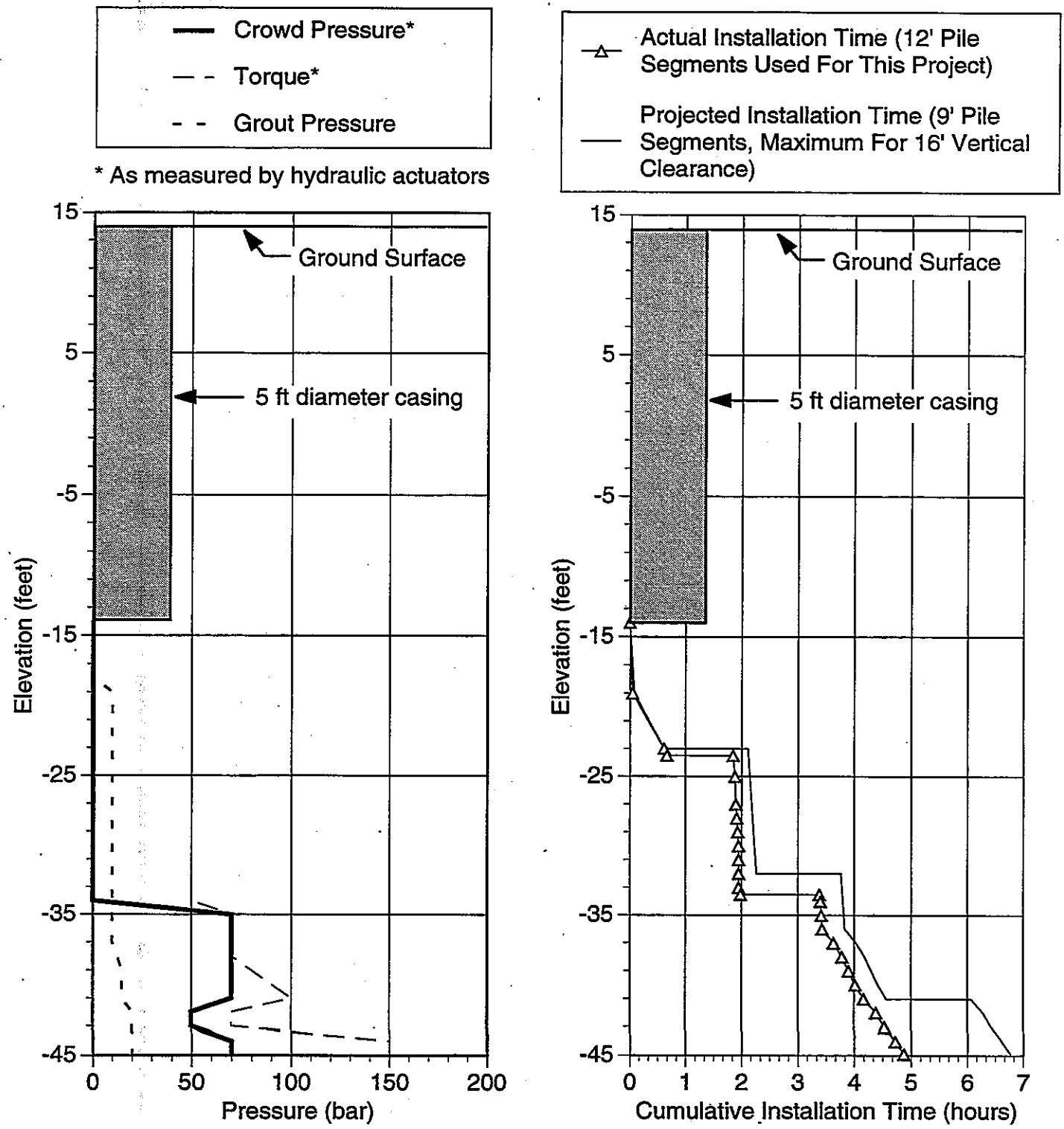
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -35.2 ft, Spec Tip El. -40 ft
Projected Installation Time 5 hrs 35 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 1

Installation Date 12/1/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -14 ft
Total Installation Time 4 hrs 24 min

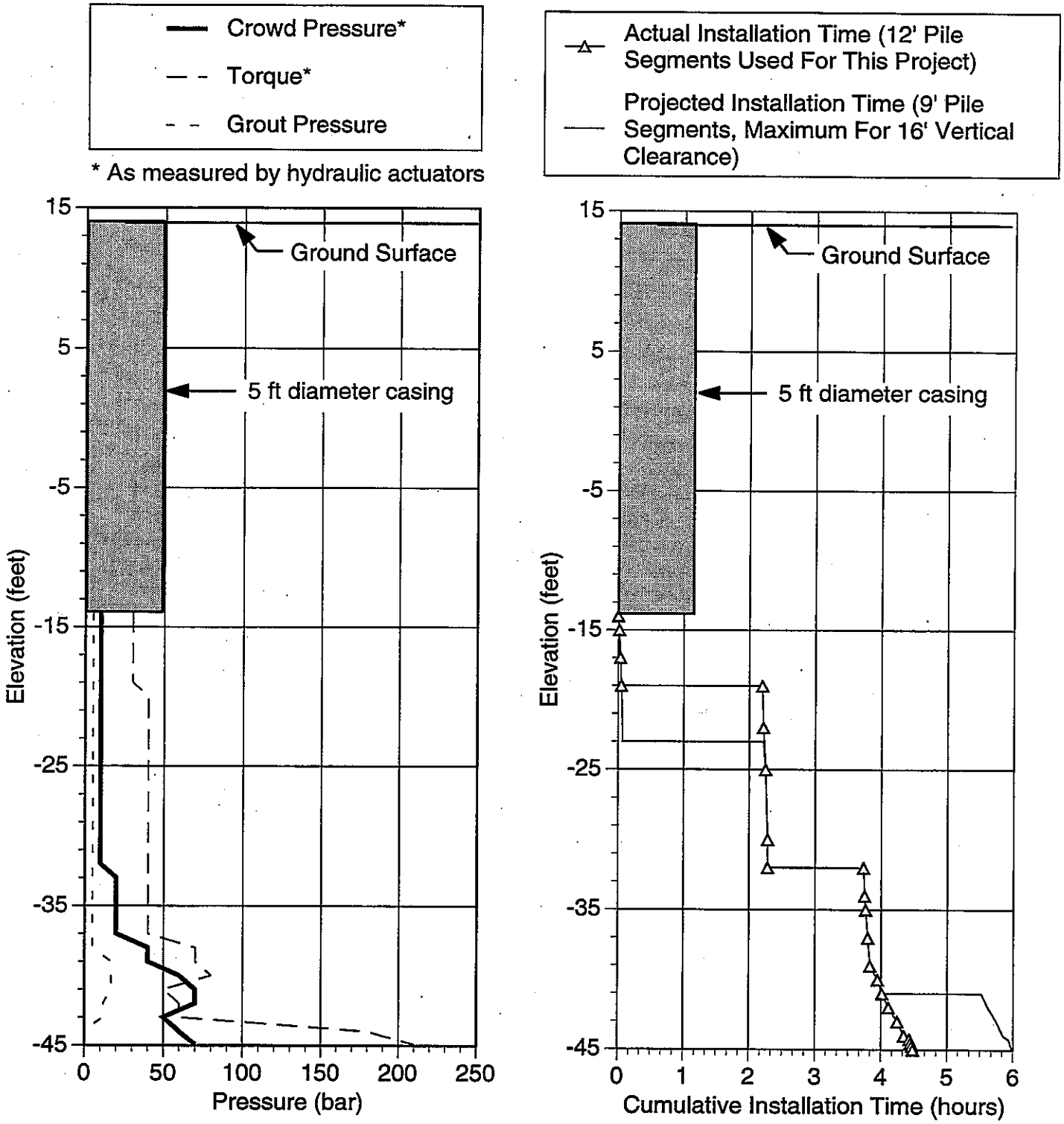
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45 ft, Spec Tip El. -45 ft
Projected Installation Time 6 hrs 11 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 2

Installation Date 11/28/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -14 ft
Total Installation Time 4 hrs 52 min

04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -44.9 ft, Spec Tip El. -45 ft
Projected Installation Time 6 hrs 46 min



Pile Installation Rates

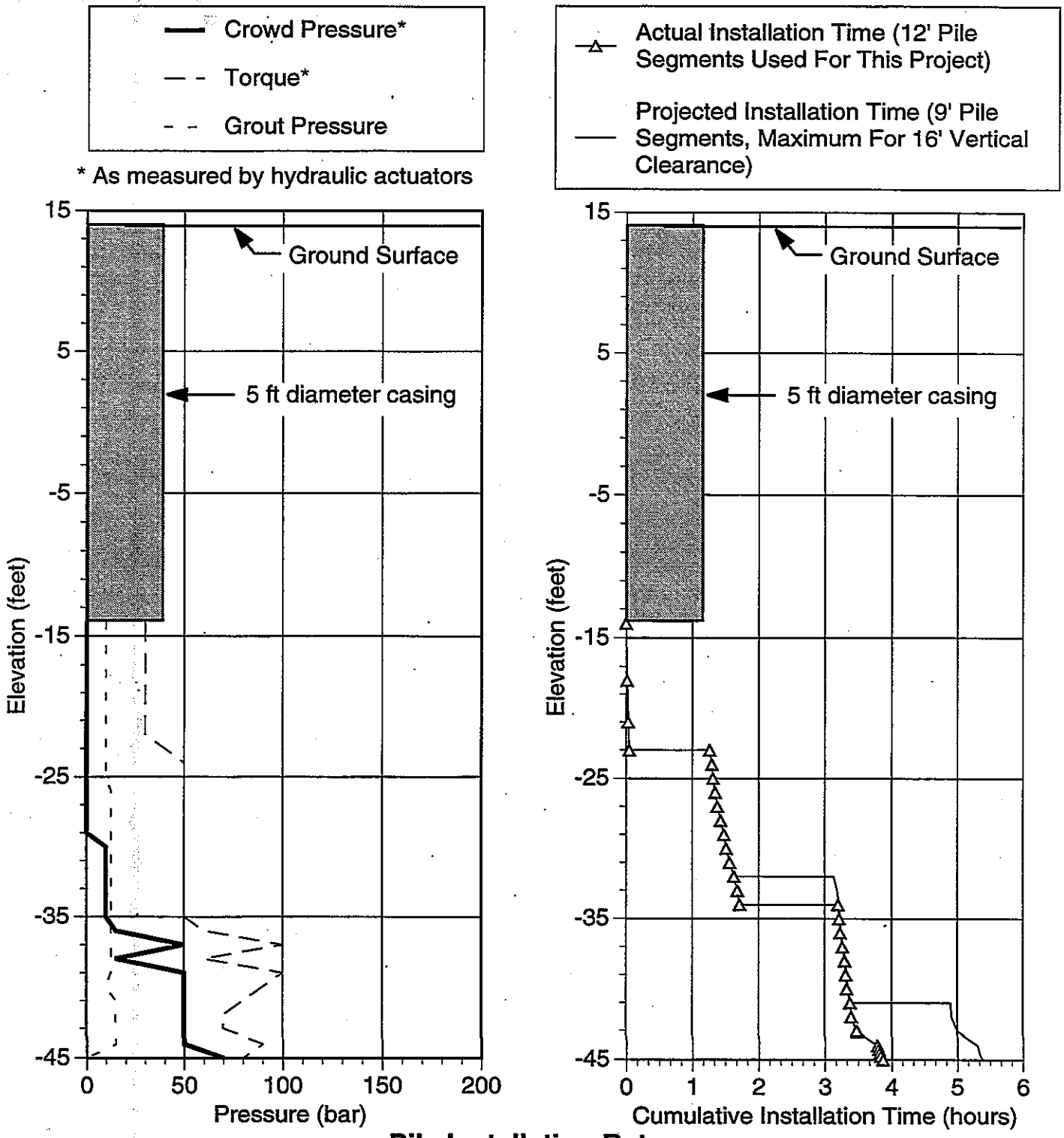
San Francisco-Oakland Bay Bridge

Indicator Pile Test Program

Site 2, Pile 3

Installation Date 11/30/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -14 ft
Total Installation Time 4 hrs 29 min

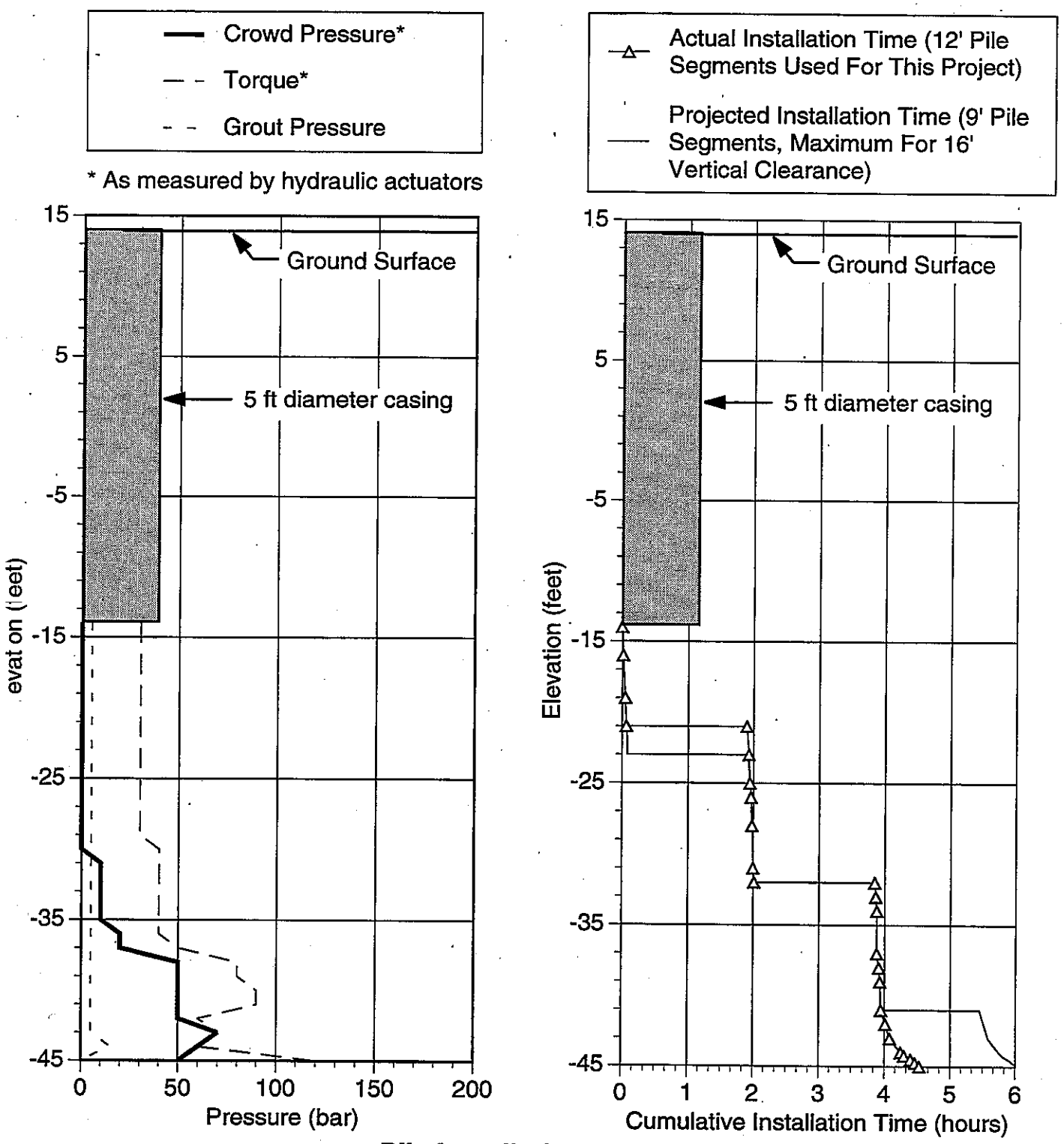
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45 ft, Spec Tip El. -45 ft
Projected Installation Time 5 hrs 59 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 4

Installation Date 11/29/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -14 ft
Total Installation Time 3 hrs 55 min

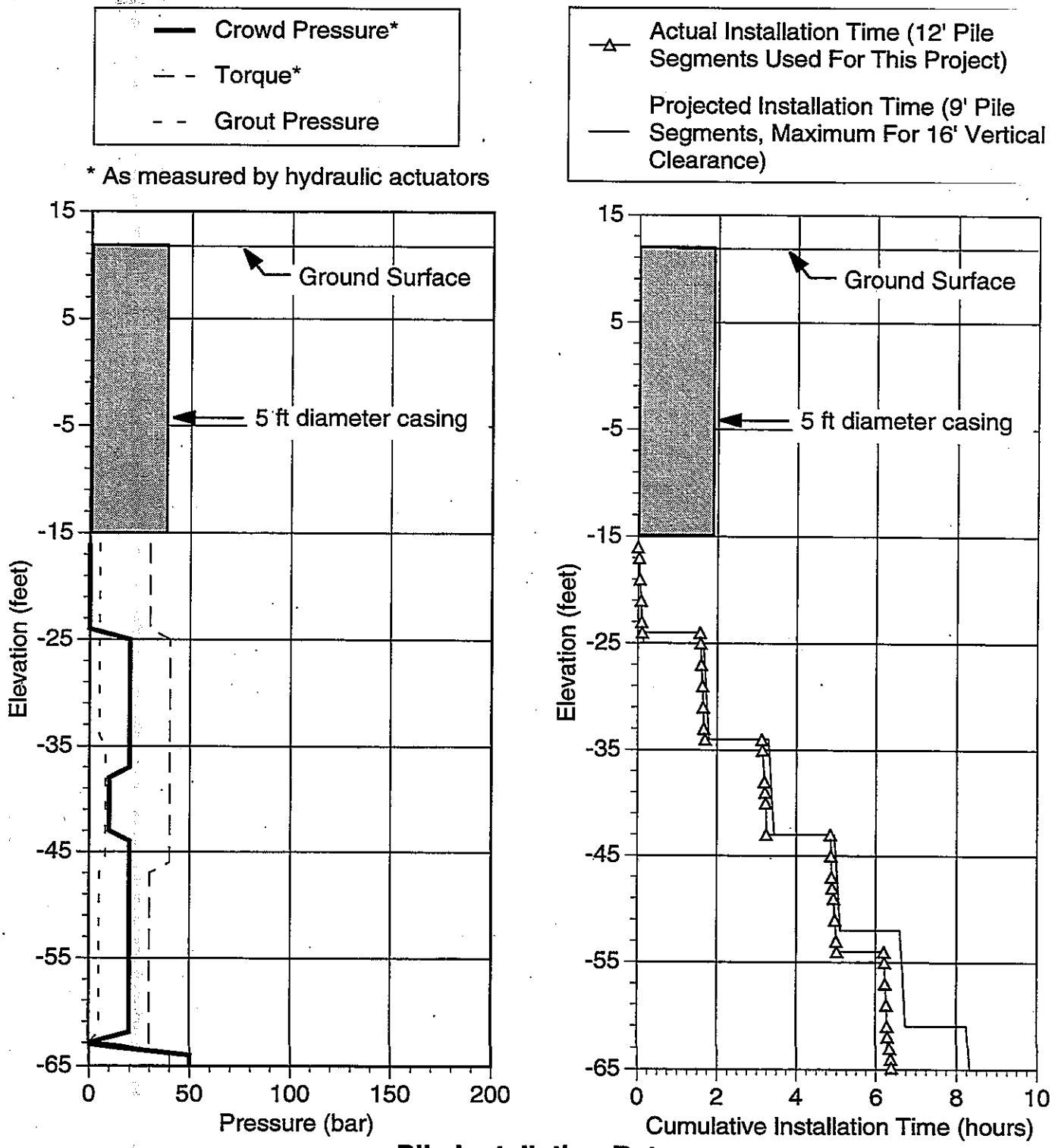
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45.2 ft, Spec Tip El. -45 ft
Projected Installation Time 5 hrs 23 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 5

Installation Date 11/29-30/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -14 ft
Total Installation Time 4 hrs 33 min

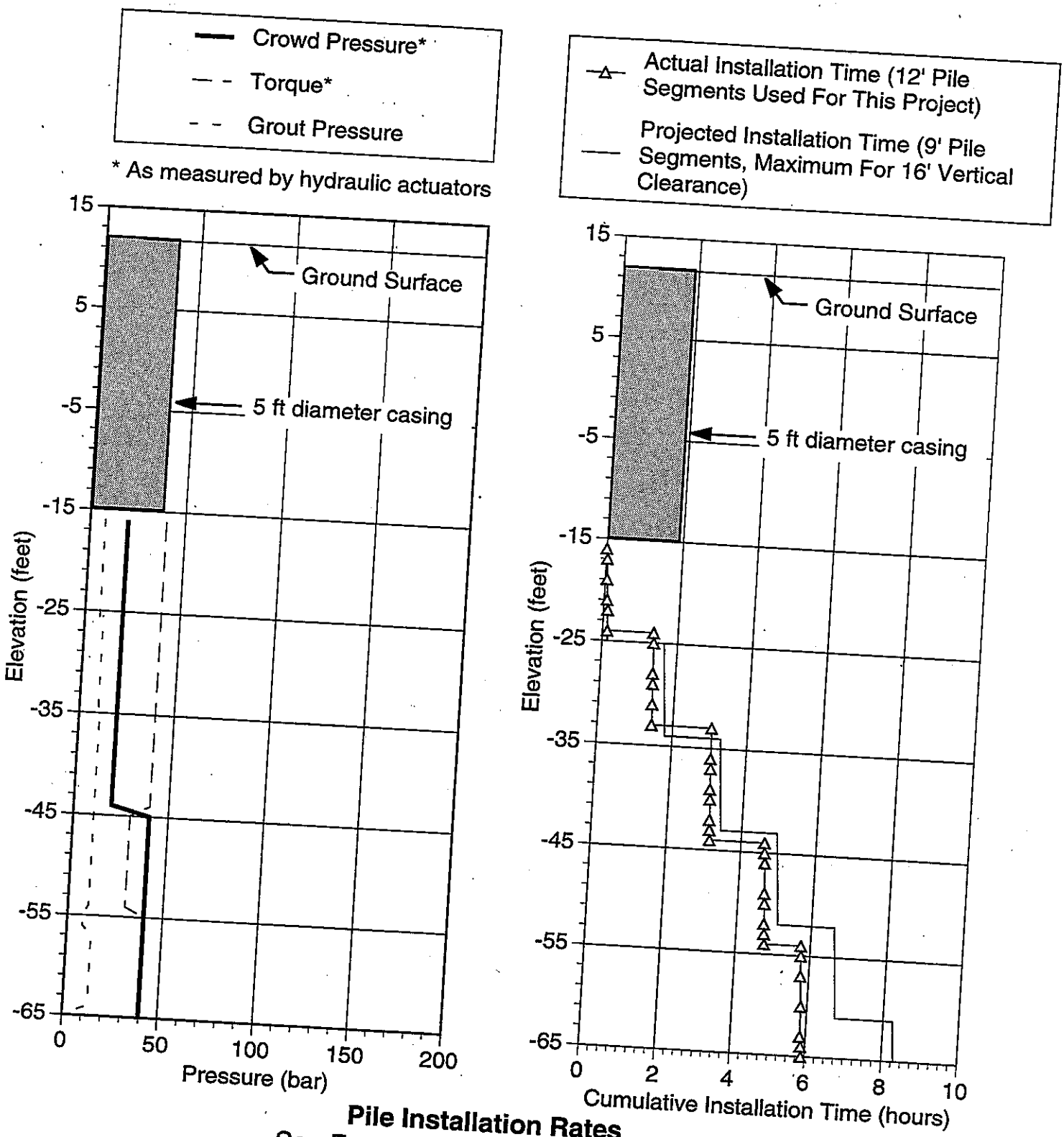
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45.2 ft, Spec Tip El. -45 ft
Projected Installation Time 6 hrs 2 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 1

Installation Date 12/6/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -15 ft
Total Installation Time 6 hrs 13 min

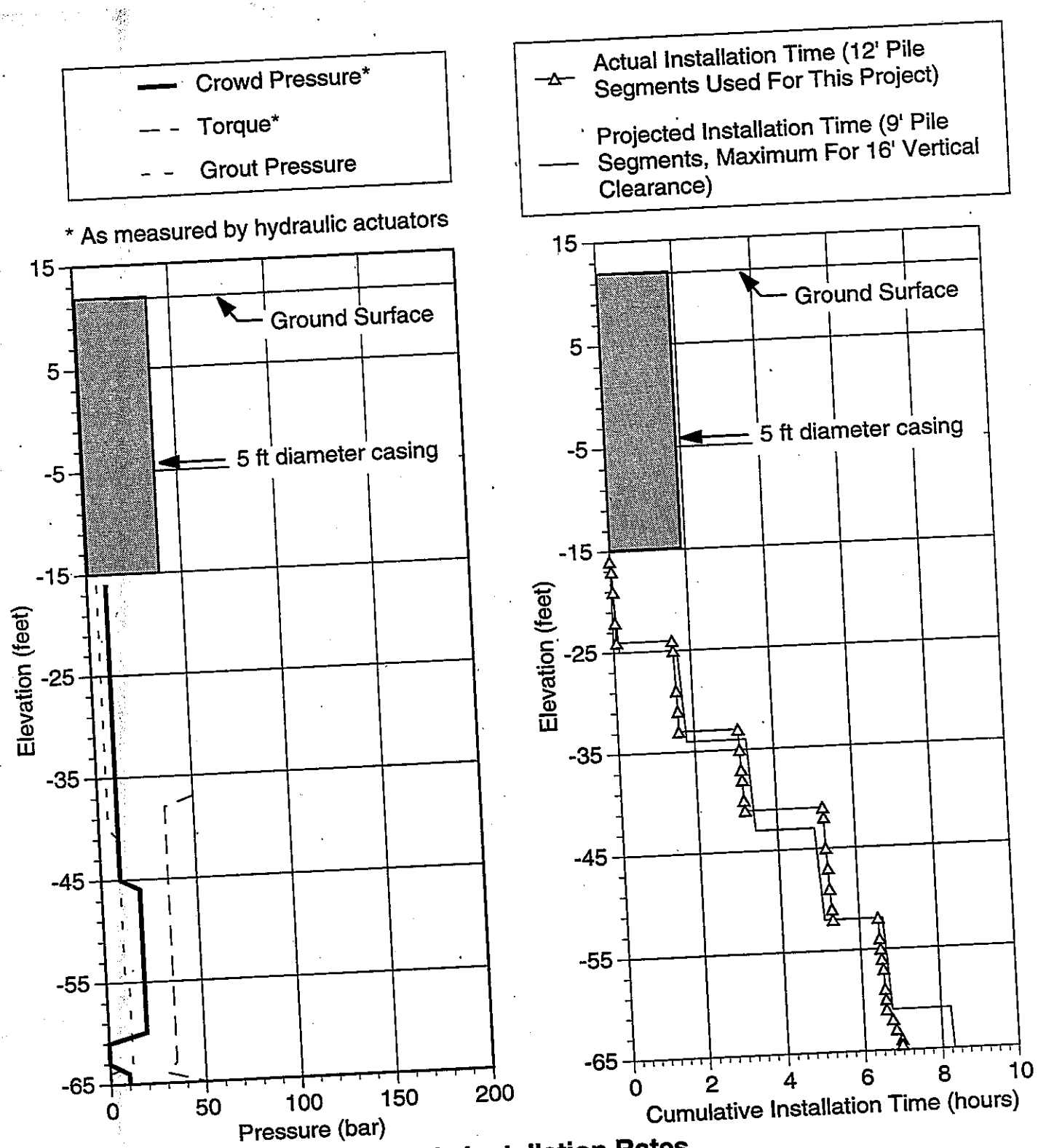
04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +12 ft
Pile Tip El. -64.8 ft, Spec Tip El. -65 ft
Projected Installation Time 8 hrs 19 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 2

Installation Date 12/8/94
04-043493
PP20" x 0.5"
Bottom of Casing El. -15 ft
Total Installation Time 5 hrs 54 min

04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +12 ft
Pile Tip El. -65 ft, Spec Tip El. -65 ft
Projected Installation Time 8 hrs 19 min



Pile Installation Rates
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 3

Installation Date 12/5/94
04-043493
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -15 ft
Total Installation Time 6 hrs 58 min

04-Ala-80-1.0/1.3
Bridge No. 33-25
Ground Surface El. +12 ft
Pile Tip El. -64.5 ft, Spec Tip El. -65 ft
Projected Installation Time 8 hrs 19 min

F INSTALLATION RECORD
: FRANCISCO-OAKLAND BAY BRIDGE
)IC:ATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used

1st Segment 43'

: 11/14/1994

SITE 1 PILE Added Pile SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

:'H	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
:	12:00	0	40	10	1	80 Gallons per batch. One Half Batch to fill up lines
1	12:01					
:	12:03	0	40		2	
:	12:22	0	60	6 to 7		
4	12:30	0	60	6 to 7		Pushing through A.C. Layer
:		0		7 to 8		
:		40	50-100			Very slow, prob A.C. Some high torque spikes to 180 bar
/		40	50-100	1 to 2		Grout off, low batch
:		50	100-120	0		Grout off, rock
:	12:43	50	100-120	0		Grout off, rock
:	12:47	60	100-150	0		Grout off. Stop-Splice simulation for 1 hour
1	13:50	50	70	5	3	
:		50	70	5		
:		50	70	5		
4		50	80	5	4	
:		50	80	5		
:		50	120	5		
/		50	120	5		
:		50	120	5		
:	14:04	40	80	5 to 10		Short pump of grout (bump) after 30 min Stop 1 hr
:	15:04	10	30	10	5	
i		10	30	10		Fast Drilling
:		10	30	10		Fast Drilling
:		10	30	10		Fast Drilling
4	15:06	10	30	10		Regrip pile
:	15:08	10	30-40	8		Fast Driving
:		10	30-40	8		Fast Driving
/	15:09	10	30-40	8		Regrip, had trouble releasing, pulled pile up 2'
:		10	30-40	8	6	Fast Driving
:		10	30-40	8		Fast Driving
:	15:14	10	30-40	8		Fast Driving. Stop to simulate welding bump @30 min
i	16:14	10	40	10		Fast Driving
:		10	40	10		Fast Driving
:		10	40	10		Fast Driving
:		10	40	10		Fast Driving
:	16:22	10	40	10		Regrip, pulled pile up 1'
:		50	40	10		
/		50	40	10		
:		50	40	10	7	Start using 7th grout batch
:		50	40	off		
:	16:29	50-60	40	off/on		Regrip
:	18:10	50	30	10	end of 7	end of 1.5 hr hold no grout pumping during hold. At the end

1.5 hr hold, pumped grout and turned the pile. Grout bubbled to surface

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	33'
2nd	12'
3rd	8'

Start Depth from Top of Casing: 17'

DATE 11/16/1994 End Depth from Top of Casing: 15.1'

SITE 1 PILE 1 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
17	11:02	0	30-40	10	1	Start Pumping Batch 1
18		0	30-40	10		
19		0	30-40	10		20' is the bottom of the casing
20		0	30-40	10		
21		0	30-40	10 to 15		
22	11:08	0	30-40	10 to 15		Regrip, 1/2 way through batch 1
23		0	30-40	10 to 15		
24		0	30-40	10 to 15		
25		0	30-40	10 to 15		
26		0	30-40	10 to 15		
27	11:10	0	30-40	10 to 15		Reset Table, pulled pile up 1"
28		0	30-40	10 to 15		
29	11:11	0	30-40	10 to 15		Stop for welding, restart at 12:48
30		0	30-40	10 to 15	2	
31	12:49	0	30-40	10 to 15		
32		0	30-40	10 to 15		
33	12:50	0	30-40	10 to 15		Reset Table
34		0	30-40	10 to 15		Intermitant grout pumping from 17' to 24'
35		0	30-40	10 to 15		
36		0	30-40	10 to 15		
37	12:53	50	50	10 to 15		Reset Table
38	12:55	50	70	10 to 15	3	Start 3rd batch
39	12:58	50	50-100	10 to 15		Drill rig moving L & R 1-2" with pile rotation
40	13:04	50	50-100	10 to 15		stuck at 22.5' for 4 minutes
41	13:17	50	50	10 to 15		Stop to weld at 13:17, restart at 14:49
42	0.6285	50	50-100	10 to 15	3 (cont)	
43	0.6368	50	40-150	10 to 15	4	Reset Table
44	0.6479	50	100-200	10 to 15		When grout is pumped, torque goes down. 250 torque
45	0.6563	50	125-200	10 to 15		is max in 1st gear, table wants to bind up. Torque
46	0.6646	50	125-200	15-20		dropped to 150 bar after grouting. At 16:22, Pile
47	0.6729	50	100-125	15-20		froze, torque hit 300, pump grout to release. At

16:35 pile froze again, tried to pump grout. Grout pump pressure went to 40 bar and then went back to 20. Could not turn pile depth from ground surface of 47.5', which gives a penetration of 27.5'. 16:40 Got off pile Pile stick-up is about 5'-7", which is about 2.5' above specified tip elevation.

E INSTALLATION RECORD
.. FRANCISCO-OAKLAND BAY BRIDGE
DICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	33'
2nd	12'
3rd	8'

Start Depth from Top of Casing: 17'

End Depth from Top of Casing: 10.1'

TE 11/17/1994

SITE 1 PILE 2 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

PIH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
18	9:28	0	50	10 to 15		Casing is 20' from ground surface, started drilling
19		0	50	10 to 15		from inside casing
20		0	50	10 to 15		Now at the bottom of the casing
21		0	50	10 to 15		
22	9:32	0	50	10 to 15		
23		0	40	10 to 15		Reset Table
24		0	40	10 to 15		
25		0	40	10 to 15		
26	9:35	0	40	10 to 15		Reset Table
27		0	40	10 to 15		
28	9:36	0	40	10 to 15		
29		0	40	10 to 15		
30	9:37	0	40	10 to 15		Stop to weld at 9:37, start at 10:57
31		0	30	10 to 15		
32		0	30	10 to 15		
33	10:59	0	30	10 to 15		
34		0	30	10 to 15		
35		0	30	10 to 15		Reset Table, pile pulled up 3"
36		0	30	10 to 15		
37		0	30	10 to 15		
38		0	30	10 to 15		
39		0	30	10 to 15		
40	11:03	0	40	10 to 15		Fundex rig front outriggers started to lift
1	11:07	50	50	10 to 15	2	Start batch 2 with high volume setting
2	11:11	50	150	10 to 15		
3	0.4688	50	150	10 to 15	2(cont)	Weld stop. Torque dropped to 50 after weld. 12:21 dor
4	0.5299	50	50	15-20	3&4	Stopped to mix more grout, restart at 12:43
5	0.5785	50	50	15-20	5 & 6	
6	0.609	50	50	15-20	7&8	
7	0.6125	50	150	0	9	stop 14:42 reset table 14:44 restart
8	0.6194	50	200	0		Bumped grout intermitantly
9	0.6278	50	80	0		Stop. Penetration 29', 1' above specified tip elevation

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	33
2nd	12
3rd	6

Start Depth from Top of Casing: 16'

DATE 11/21/1994 End Depth from Top of Casing: 15.3'

SITE 1 PILE 3 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
18	14:49	0	40	10	1	
19		0	40	10		
20	14:50	0	40	10		
21		0	40	10		Stop to Regrip at 14:51, restart at 14:52
22		0	40	10		
23	14:52	0	40	10		
24		0	40	10		
25	14:53	0	40	10		Stop to Regrip at 14:53, restart at 14:54
26	14:54	0	40	10		
27		0	40	10		
28		0	40	10		
29		0	40	10		
30	14:55	0	40	10		14:55 Stop to weld, 15:08 start welding, 16:15 restart
31		0	40	15		
32		0	40	15		
33		0	40	15		Regrip
34	16:16	0	40	15		
35		0	40	15		
36		50	40	15		
37	16:18	50	40	15		
38	16:18	50	50	15		
39	16:19	50	60	15	2	Regrip, 16:21 start batch 2 at 39.5'
40	16:24	50	100	15		
41	16:26	50	120	15		
42	16:28	60	140	0	2 (cont)	16:28 stop to weld, restart at 17:52
43	18:09	60	50	15	3	18:06 go to batch 3, continuous grout pumping
44	18:17	70	60	17		
45	18:30	60	110	13		
46	18:52	60	200	13		end at 19:16 at 46.5'
Readings Taken at Intermediate Points						
45'-8"	18:42					
45'-9"	18:46					Stop at 18:47:30 to regrip, restart at 18:49:30
45'-10"	18:50					
45'-11"	18:51					
46'-0"	18:52					
46'-1"	18:53					
46'-2"	18:54					
46'-3"	18:55					
46'-4"	18:56					
46'-5"	18:57					
46'-6"	18:58					Regrip for 1 minute
46'-7"	19:00					Pile rose 1.5" due to grout pumping
46'-6"	19:14					19:11:27 stop to regrip, 19:13:12 restart

F INSTALLATION RECORD
AN FRANCISCO-OAKLAND BAY BRIDGE
DICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	33'
2nd	12'
3rd	6'

Start Depth from Top of Casing: 17.9'

End Depth from Top of Casing: 15.7'

11/21/1994

SITE 1 PILE 4 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

PILE	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
19	7:56	0	50	10	1	
20		0	50	10		
21		0	50	10		
22	7:58	0	50	10		
23		0	50	10		
24	8:00	0	50	10		
25		0	50	10		
26		0	50	10		
27		0	50	10		
28	8:01	0	50	10		Regrip 8:01 to 8:02
29		0	50	10		
30		0	50	10		
31	8:03	0	50	10		Bump Grout at 15 min intervals
32	9:52	0	50	10		
33		0	50	20	2	
34		0	50	20		
35		0	50	20		
36		0	50	20		
37		50	50	20		
38		50	50	20		
39	9:56	50	50	20		Regrip at 9:56
10	9:59	50	60	0		Grout pumping is intermittant
11	10:01	50	100	0	3	
12	10:11	50	120	0	4	Stop to weld at 10:11, Batch 4 at 11:55, Start 11:45
13	12:05	50	100	30		12:05 start constant grout pumping
14	0.5111	70	130	0	4 (cont)	13:15 stop at 45.2'
15	0.5417	50	120	25-30		only used 1/3 of grout batch #4

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	33'
2nd	12'
3rd	6'

Start Depth from Top of Casing: 18'

DATE 11/18/1994 End Depth from Top of Casing: 14.9'

SITE 1 PILE 5 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

		readings in bar (14.5 psi)				
DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
22.5	9:20	0	30	15	1	Depth is from ground surface, pile pushed to 22.5'
23		0	30	15		Bottom of casing is 20' depth
24		0	30	15		
25		0	30	15		
26		0	30	15		9:21 reset table-jaws stuck, 9:25 restart
27		0	30	15		
28		0	30	15		
29		0	30	15		
30		0	30	15		9:27 stop for weld, bump at 15 min intervals
31	11:00	0	40	15		
32		0	40	15		
33		0	40	15		
34		0	40	15		
35		0	40	15		
36		0	40	15		
37	11:04	0	40	15		
38		0	40	15		
39	11:05	50	50	15	2	Reset Table at 39.5', 11:08, batch 2 start at 11:05
40	11:10	50	80	15		
41	11:15	50	40	15		
42	11:21	50	120	0		Stopped cont pumping, now only when torque>150
43	13:13	50	120	0		11:24 stop to weld at 42.5', restart at 13:10.
44	13:30	50	120	0		Bumped grout @15 min intervals to end of drilling
45	14:00	50	200	0	3	Reset Table, start 3rd batch at 14:22
46						Stop at 45.2' from ground surface at 14:55

F INSTALLATION RECORD
.. FRANCISCO-OAKLAND BAY BRIDGE
)IC:ATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	40'
2nd	11'
3rd	11'

Start Depth from Top of Casing: 26.5'

End Depth from Top of Casing: 23.6'

12/1/1994

SITE 2 PILE 1 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27						
28	8:58	10	30	12	1	This pile will be installed by pumping grout
29	8:59	10	30	12		during drilling
30	8:59	10	30	12		
31	9:00	10	30	12		
32	9:00	10	30	12		Reset Table 9:00, restart at 9:02
33	9:03	10	30	12		
34	9:03	10	30	12		
35	9:03	10	30	12		
36	9:04	10	30	12		9:04 stop to weld, at 36.3', restart at 10:28
37	10:28	10	30	12		
38	10:29	10	30	12		
39		10	30	12		
10	10:29	10	30	12		
11	10:29	10	30	12		10:29 reset table
12	10:30	20	40	12	2	
13		20	40	12		
14	10:31	20	40	12		
15	10:32	20	40	12		10:32 reset table
16	10:32	20	40	12		
17	10:34	20	40	12		10:34 stop to weld at 47.75', 12:02 restart
18	12:02	20	40	12		
19	12:02	20	40	12	3	
20	12:03	20	40	12		
21	12:04	40	50	14		Intermittant grout pumping
22	0.5049	70	60	14		12:09 reset table
23	0.5111	70	60	14		at 53.5' at 12:19, torque was at 150
24	0.5174	70	100	14	4	at 54.5' at 12:28, torque was at 160
25	0.5222	70	120	22		at 55.5' at 12:38, torque was at 100
26	0.5292	60	60	22		at 56.5' at 12:48, torque was at 120
27	0.5368	60	150	22		12:53 reset table
28	0.5472	70	100	22		13:14 at 58.5' switch fundex rig to low gear
29	0.5569	70	100	22		Finished

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	40'
2nd	11'
3rd	11'

Start Depth from Top of Casing: 28'
End Depth from Top of Casing: 24'

DATE 11/28/1994

SITE 2 PILE 2 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

DEPTH	TIME	readings in bar (14.5 psi) CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27	9:40					Pile pushed 5 feet while plumbing the pile
28						
29						
30						
31						
32						
33	9:43	0	50	10	1	
34		0	50	10		
35		0	50	10		
36		0	50	10		
37	10:17	0	50	10		Stop at 37.5' at 10:20 to weld. Restart at 11:31
38		0	50	10		
39	11:33	0	50	10		
40		0	50	10		
41	11:34	0	50	10		
42	11:35	0	50	10		11:35 regrip, restart 11:36
43	11:36	0	50	10	2	
44	11:37	0	50	10		
45	11:37	0	50	10		
46	11:37	0	50	10		
47	11:37	0	50	10		11:38 regrip, 11:39 restart
48	13:04	0	50	10		11:39 stop to weld ar 47.5', restart at 13:03
49	13:05	70	70	10		
50	13:06	70	70	10	3	
51	13:18	70	70	10		13:07 ran out of grout at 57.75', restart at 13:14
52	13:27	70	70	10 to 15	3 (cont)	
53	13:34	70	80	15		
54	13:41	70	90	15	4	Start 4 th batch at 54.5'
55	13:50	70	100	15		
56	14:03	50	70	20		
57	14:12	50	70	20		Stop grouting
58	14:23	70	150	20		14:32 stop at 58.9'
Readings taken at intermediate points						
52.25	13:29	70	50-150	15	3	
52.5	13:30	70	50-150	15		
52.75	13:33	70	50-150	15		
53.25	13:36	70	50-150	15		
53.5	13:38	70	50-150	15		
55.5	13:59	70	50-150	20	4	
56.5	14:05	50	50-150	20		
57.5	14:17	50	50-150	20		
58.25	14:27	70	50-150	20		
58.5	14:29	70	200	50		Switched to high torque gear on Fundex machine
58.75	14:31	70	150	50		Switched to high torque gear on Fundex machine
58.9	14:32	70	150	50		Switched to high torque gear on Fundex machine

E INSTALLATION RECORD
.. FRANCISCO-OAKLAND BAY BRIDGE
..ICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	37
2nd	12.5
3rd	12.5

Start Depth from Top of Casing: 26.5'

End Depth from Top of Casing: 23.5'

.. 11/30/1994

SITE 2 PILE 3 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

		readings in bar (14.5 psi)				
	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27	12:29	10	30	5	*	* This pile will be installed the "Fundex" way
28		10	30	5		using water instead of grout to within 5 ft of
29	12:30	10	30	5		specified tip elevation
30		10	30	5		
31	12:31	10	30	5		
32		10	30	5		
33	12:32	10	30	5		stop to weld at 12:33 at 33.75', restart at 14:41
34	14:41	10	40	5		weld inspection made this splice take this long
35	14:41	10	40	5		
36	14:42	10	40	5		
37	14:42	10	40	5		
38	14:42	10	40	5		reset table at 14:42, restart at 14:43
39	14:44	10	40	5		
10	14:44	10	40	5		
11	14:44	10	40	5		
12	14:44	10	40	5		
13	14:44	10	40	5		reset table at 14:44, restart at 14:45
14	14:46	10	40	5		
15	14:46	10	40	5		
16	14:46	10	40	5		14:46 stop to weld, 16:13 restart
17	16:13	20	40	5		
18	16:14	20	40	5		
19	16:15	20	40	5		
20	16:15	20	40	5		16:15 reset table, 16:17 restart
21	16:17	20	40	5		
22	16:17	40	70	5		
23	16:19	40	70	17	1	stop for grout 16:24 restart, constant grout pumping
24	16:26	60	80	17		
25	16:30	70	50	17		intermittant pumping of grout
26	16:36	70	60	12	2	
27	16:44	50	60	12	3	intermittant pumping of grout
28	16:50	60	180	0		16:50 stop to reset table,16:51 restart
25	16:55	70	100	0		end of 3rd batch of grout
5	16:56	70	210	0		
75	16:57	70	210/120	0		switched fundex rig to low gear torque reading went
0	16:58	70	170	0		from 210 to 120 bar but there is a different scale for
						the 2nd gear. 16:58 end of driving

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	37'
2nd	12.5'
3rd	12.5'

Start Depth from Top of Casing: 28.5'

End Depth from Top of Casing: 24.0'

DATE 11/29/1994

SITE 2 PILE 4 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27					*	* This pile will be installed the "Fundex" way
28						using water instead of grout to within 5 ft of
29	8:25	0	30	10		specified tip elevation
30		0	30	10		
31		0	30	10		
32	8:26	0	30	10		
33		0	30	10		
34		0	30	10		
35	8:27	0	30	10		
36		0	30	10		
37	8:28	0	40	10		
38	9:43	0	40	10		
39	9:44	0	50	10		
40	9:46	0	50	13		
41	9:48	0	50	13		
42	9:51	0	50	13		
43	9:54	0	50	13		
44	9:56	10	50	13		
45	9:59	10	50	13		
46	10:03	10	50	13		
47	10:06	10	50	13		
48	10:08	10	50	13		Stop to weld 9:48 start weld at 10:08 start at 11:37
49	11:38	10	50	13		
50	11:39	15	60	13		
51	11:41	50	100	13		
52	11:43	15	60	13		
53	11:44	50	100	13		
54	11:45	50	90	10	1	11:45 to 11:48 stop to switch to grout
55	11:48	50	80	15		
56	11:49	50	70	15		11:51 to 11:53 regrip, pile pulled up 5 inches
57	11:54	50	70	15		11:55 stop to mix more grout, 12:09 restart
58	12:12	50	90	15	2	
58.25	12:13	50	90	15	3	
58.5	12:14	70	80	15		
58.75	12:15	70	80	10		Continued turning until the rest of the grout from the
59	12:17	70	80	10		lines is pumped through, the reset tip into sand
59.5	12:20	50	80	0		Installation completed

F INSTALLATION RECORD
.. FRANCISCO-OAKLAND BAY BRIDGE
)ICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used	
1st Segment	37'
2nd	12.5'
3rd	12.5'

Start Depth from Top of Casing: 26.5'

End Depth from Top of Casing: 24.5'

1F 11/29-30/1994

SITE 2 PILE 5 SHEET 1 OF 1 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

PIH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27					*	* This pile will be installed the "Fundex" way
28	13:40	0	30	5		using water instead of grout to within 5 ft of
29		0	30	5		specified tip elevation
30	13:41	0	30	5		
31	13:41	0	30	5		
32	13:41	0	30	5		13:42 stop to reset table
33	13:43	0	30	5		
34	13:43	0	30	5		13:44 stop to weld, will finish tomorrow
35	8:29	0	30	5		
36		0	30	5		
37	8:31	0	30	5		
38		0	30	5		
39	8:32	0	30	5		reset table
10	8:33	0	30	5		
11	8:33	0	30	5		
12	8:34	0	30	5		
13	8:34	0	30	5		
14	8:34	0	40	5		reset table
15	8:35	10	40	5		
16	8:36	10	40	5		8:36 stop to weld, 10:26 restart
17	10:27	10	40	5		
18	10:28	10	40	5		
19		10	40	5		
20		20	40	5		
21	10:28	20	50	5		reset table
22	10:30	50	80	5		
23	10:31	50	80	5		
24	10:31	50	90	5		
25	10:32	50	90	5		reset table and switch from water to grout
26	10:36	50	60	5	1	
27	10:40	70	70	5		stop to finish mixing batch 2
28	10:50	60	60	10	2 and 3	at 58.2' no crowd, spin only until grout batch pumped
25	10:53	60	60	10		then seat tip at 59', 3 rd batch started at 10:58
5	10:59	60	60	15		
75	11:03	60	60	15		finished pumping 3rd batch
2	11:07	40	100	0		
2	11:08	50	120	0		Installation completed

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	10'
2nd	10'		
3rd	10'		
4th	10'		

Start Depth from Top of Casing: 25'

End Depth from Top of Casing: 23'

DATE 12/6/1994

SITE 3 PILE 1 SHEET 1 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
27	9:56	0	30	5	1	This pile will be installed by grouting the pile
28		0	30	5		during drilling
29	9:58	0	30	5		
30		0	30	5		
31	9:59	0	30	5		
32		0	30	5		
33	10:01	0	30	5		
34		0	30	5		
35	10:02	0	30	5		
36	10:03	0	30	5		stop to weld at 36.5' at 10:04, restart at 11:30
37	11:31	20	40	5	2	
38	11:31	20	40	5		
39	11:32	20	40	5		
40	11:32	20	40	5		reset table
41	11:34	20	40	5		
42		20	40	5		
43	11:35	20	40	5		
44		20	40	5		
45	11:36	20	40	5		reset table, pile pulled up 3"
46	11:38	20	40	5		stop to weld at 11:38, restart at 13:08
47	13:09	20	40	8		
48		20	40	8	3	
49		20	40	8		
50	13:12	10	40	8		
51	13:13	10	40	8		

F INSTALLATION RECORD
: FRANCISCO-OAKLAND BAY BRIDGE
)ICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	10'
2nd	10'		
3rd	10'		
4th	10'		

Start Depth from Top of Casing: 25'

End Depth from Top of Casing: 23'

'E 12/6/1994

SITE 3 PILE 1 SHEET 2 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

PILE	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
2	13:14	10	40	8		
3	13:14	10	40	8		
4	13:14	10	40	8		
5	13:15	10	30	8		13:16 stop to weld at 55.5', restart at 14:47
6	14:47	20	30	8	4	
7	14:48	20	30	8		
8	14:48	20	30	8		
9	14:49	20	30	5		
0	14:50	20	30	5		stop to reset table, pile pulled up 1'
1	14:52	20	30	5		
2	14:52	20	30	5		
3	14:54	20	30	5		
4	14:54	20	30	5	5	stop to reset table, pile pulled up 4"
5	14:56	20	30	5		
6	14:57	20	30	5		14:57, stop to weld at 66.2', restart at 16:08
7	16:09	20	30	5		
8		20	30	5		
9	16:10	20	30	5		
0		20	30	5		
1	16:12	20	30	5		
2		20	30	5		
3	16:13	20	30	5		
4	16:14	20	30	5		Spin only, no crowd pressure
5	16:16	0	40	0		Spin only, no crowd pressure
6	16:18	50	40	0		Crowd pressure at end. End at 76.8' at 16:19

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	10'
2nd	10'		
3rd	10'		
4th	10'		

Start Depth from Top of Casing: 27'

End Depth from Top of Casing: 23.5'

DATE 12/8/1994

SITE 3 PILE 2 SHEET 1 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
28	8:33	20	40	8	1	This pile will be installed by pumping grout
29	8:35	20	40	8		during installation
30		20	40	8		
31	8:36	20	40	8		
32		20	40	8		Reset table and plumb pile
33	8:38	20	40	8		pull up pile to 32' to replumb
34	8:40	20	40	8		
35		20	40	8		
36	8:41	20	40	8		Stop to weld at 8:41, restart at 9:55
37	9:56	20	40	8	2	
38		20	40	8		
39		20	40	10		
40	9:57	20	40	10		Reset Table at 40.5'
41	9:58	20	40	10		
42		20	40	10		
43	9:59	20	40	10		
44		20	40	10		
45	10:00	20	40	10		10:00 stop to weld, restart at 11:36
46	11:36	20	40	10		
47		20	40	10		
48	11:37	20	40	11	3	
49	11:38	20	40	11		
50		20	40	11		Reset table
51	11:39	20	40	11		
52	11:40	20	40	11		

F INSTALLATION RECORD
: FRANCISCO-OAKLAND BAY BRIDGE
)IC:ATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	10'
2nd	10'		
3rd	10'		
4th	10'		

Start Depth from Top of Casing: 27'

12/8/1994 End Depth from Top of Casing: 23.5'

SITE 3 PILE 2 SHEET 2 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

in	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
3	11:40	20	40	11	3(cont)	
4	11:41	20	40	11		Reset table
5	11:42	20	40	11		
6	11:43	20	40	11		Stop to weld at 11:43, restart at 13:11
7	13:12	40	30	11		
8	13:13	40	30	11	4	
9		40	30	11		
0		40	30	11		Reset table
1	13:15	40	30	11		
2	13:16	40	30	11		
3		40	30	11		
4	13:17	40	30	11		
5	13:18	40	30	11		
6	13:19	40	30	11		stop to weld at 13:19, restart at 14:18
7	14:19	40	40	8	5	
8		40	40	8		
9	14:20	40	40	13		
0		40	40	13		Reset table, pile pulled 4 inches
1		40	40	13		
2	14:23	40	40	13		
3		40	40	13		
4		40	40	13		
5	14:24	40	40	13		Reset table
6	14:26	40	40	13		Stop crowd pressure to pump rest of grout
7	14:27	40	40	0		

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	12'
2nd	8.5'		
3rd	8.5'		
4th	11'		

Start Depth from Top of Casing: 25'

End Depth from Top of Casing: 23'

DATE 12/5/1994

SITE 3 PILE 3 SHEET 1 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
28	9:01	10	50	5	*	* This pile will be installed the Fundex method, that
29	9:02	10	50	5		is, using water during drilling to get near specified tip
30		10	50	5		
31	9:04	10	50	5		
32		10	50	5		
33		10	50	5		
34	9:05	10	50	5		
35		10	50	5		
36	9:06	10	50	5		9:06 stop to weld, restart at 10:33
37	10:33	10	50	5		
38	10:34	10	50	5		
39		10	50	5		
40		10	50	5		
41	10:36	10	50	5		reset table
42		10	50	5		
43	10:37	10	50	5		
44		10	50	5		
45	10:37	10	50	5		10:37 stop to weld, 12:08 restart
46	12:08	10	50	5		
47	12:09	10	50	5		
48		10	50	5		
49	12:10	10	50	5		
50	12:11	10	30-40	5		
51		10	30-40	5		
52	12:12	10	30-40	5		

E INSTALLATION RECORD
: FRANCISCO-OAKLAND BAY BRIDGE
)IC:ATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	12'
2nd	8.5'		
3rd	8.5'		
4th	11'		

Start Depth from Top of Casing: 25'

: 12/5/1994 End Depth from Top of Casing: 23'

SITE 3 PILE 3 SHEET 2 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

...	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
3	12:12	10	30-40	10		12:13 stop to weld, restart at 14:12
4	14:13	10	30-40	10		
5		10	30-40	10		
6		10	30-40	10		
7	14:14	10	30-40	10		
8		20	30-40	10		
9	14:16	20	30-40	10		
0		20	30-40	10		
1	14:17	20	30-40	10		
2		20	30-40	10		14:17 reset table, pile pulled 4 inches, 14:18 restart
3	14:19	20	30-40	10		
4	14:19	20	30-40	10		14:20 stop to weld, restart at 15:30
5	15:30	20	30-40	10		
6	15:31	20	30-40	10		
7	15:32	20	30-40	12	1	15:33 start grout
8	15:33	20	30-40	12		reset table
9	15:35	20	30-40	12		
0		20	30-40	12		
1	15:36	20	30-40	12		
2	15:37	20	30-40	12		
3	15:37	0	30-40	12		turning only, no crowd pressure
4	15:46	0	30-40	12	2	
5	15:51	0	30	12	3 & 4	15:52 start grout batch 4, 15:58 end of pumping grout
6	15:59	10	50	0		
5	15:59	10	50	0		

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	12'
2nd	8.5'		
3rd	8.5'		
4th	11'		

Start Depth from Top of Casing: 24'

End Depth from Top of Casing: 22'

DATE 12/9/1994

SITE 3 PILE 4 SHEET 1 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
28	7:42	20	30	5	*	* This pile will be installed the Fundex method, that
29		20	30	5		is, using water during drilling to get near specified tip
30	7:43	20	30	5		
31		20	30	5		
32		20	30	5		
33	7:44	20	30	5		Reset table
34		20	30	5		
35		20	30	5		
36	7:45	20	30	5		7:45 stop to weld, restart at 10:10
37	10:10	20	30	5		
38		20	30	5		
39	10:11	20	30	5		
40		20	40	5		
41	10:12	20	40	5		Reset table
42		20	40	5		
43	10:14	20	40	5		
44		20	40	5		
45	10:15	20	40	5		10:15 stop to weld, 11:35 restart
46	11:35	20	40	5		
47	11:36	20	40	5		
48		20	40	5		
49	11:37	20	40	5		
50		20	40	5		Reset table
51	11:39	20	40	5		
52		20	40	5		

F INSTALLATION RECORD
: FRANCISCO-OAKLAND BAY BRIDGE
)ICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	12'
2nd	8.5'		
3rd	8.5'		
4th	11'		

Start Depth from Top of Casing: 24'

12/9/1994 End Depth from Top of Casing: 22'

SITE 3 PILE 4 SHEET 2 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

PTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
3	11:40	20	40	5		11:40 stop to weld, restart at 12:40
4	12:40	20	40	5		
5		20	40	5		
6	12:41	20	40	5		
7		20	40	5		Reset table
8	12:43	20	40	5		
9		20	40	5		
0		20	40	5		
1	12:44	20	40	5		
2		20	40	5		Reset table
3	12:45	20	40	5		
4	12:46	20	40	15	1	12:46 stop to weld, restart at 14:19, also start grout
5	14:19	20	40	15		
6	14:20	20	40	15		
7		20	40	15		
8	14:21	20	40	15		
9		20	40	15		Reset table
0	14:23	20	40	15	2	14:23 Hydraulic hose blew, restart at 14:29
1	14:30	20	40	15		
2	14:32	20	40	15		
3	14:33	20	40	15		
4	14:34	20	40	15	3	Turn only, no crowd pressure during grout making
5	14:43	40	40	15	4	14:41 start pumping grout batch 4, and using
6	14:44	40	50	15		crowd pressure
7	14:45	40	70	0		

PILE INSTALLATION RECORD
SAN FRANCISCO-OAKLAND BAY BRIDGE
INDICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	11'
2nd	8.5'		
3rd	8.5'		
4th	12'		

Start Depth from Top of Casing: 25'

End Depth from Top of Casing: 23.5'

DATE 12/7/1994

SITE 3 PILE 5 SHEET 1 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

DEPTH	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
28	8:52	10	30	5	*	* This pile will be installed the Fundex method, that
29	8:53	10	30	5		is, using water during drilling to get near specified tip
30		10	30	5		
31	8:54	10	30	5		
32		10	30	5		
33	8:55	10	30	5		
34		10	30	5		
35	8:56	10	30	5		
36		20	30	5		
37	8:57	20	30	5		8:57 stop to weld, 10:20 restart
38	10:20	20	30	5		
39		20	30	5		
40	10:21	20	30	5		
41		20	30	5		
42	10:22	20	30	5		
43		20	30	5		
44	10:24	20	30	5		
45		20	30	5		10:24 stop to weld, 11:42 restart
46	11:42	20	30	5		
47	11:43	20	30	5		
48		20	30	5		
49	11:44	20	30	5		Reset table
50		10	40	5		
51	11:45	10	40	5		
52		10	40	5		

E INSTALLATION RECORD
FRANCISCO-OAKLAND BAY BRIDGE
ICATOR PILE TEST PROGRAM

Lengths of Pipe Pile Used			
1st Segment	40'	5th	11'
2nd	8.5'		
3rd	8.5'		
4th	12'		

Start Depth from Top of Casing: 25'

End Depth from Top of Casing: 23.5'

E 12/7/1994

SITE 3 PILE 5 SHEET 2 OF 2 INSPECTOR Lincoln Leaman

readings in bar (14.5 psi)

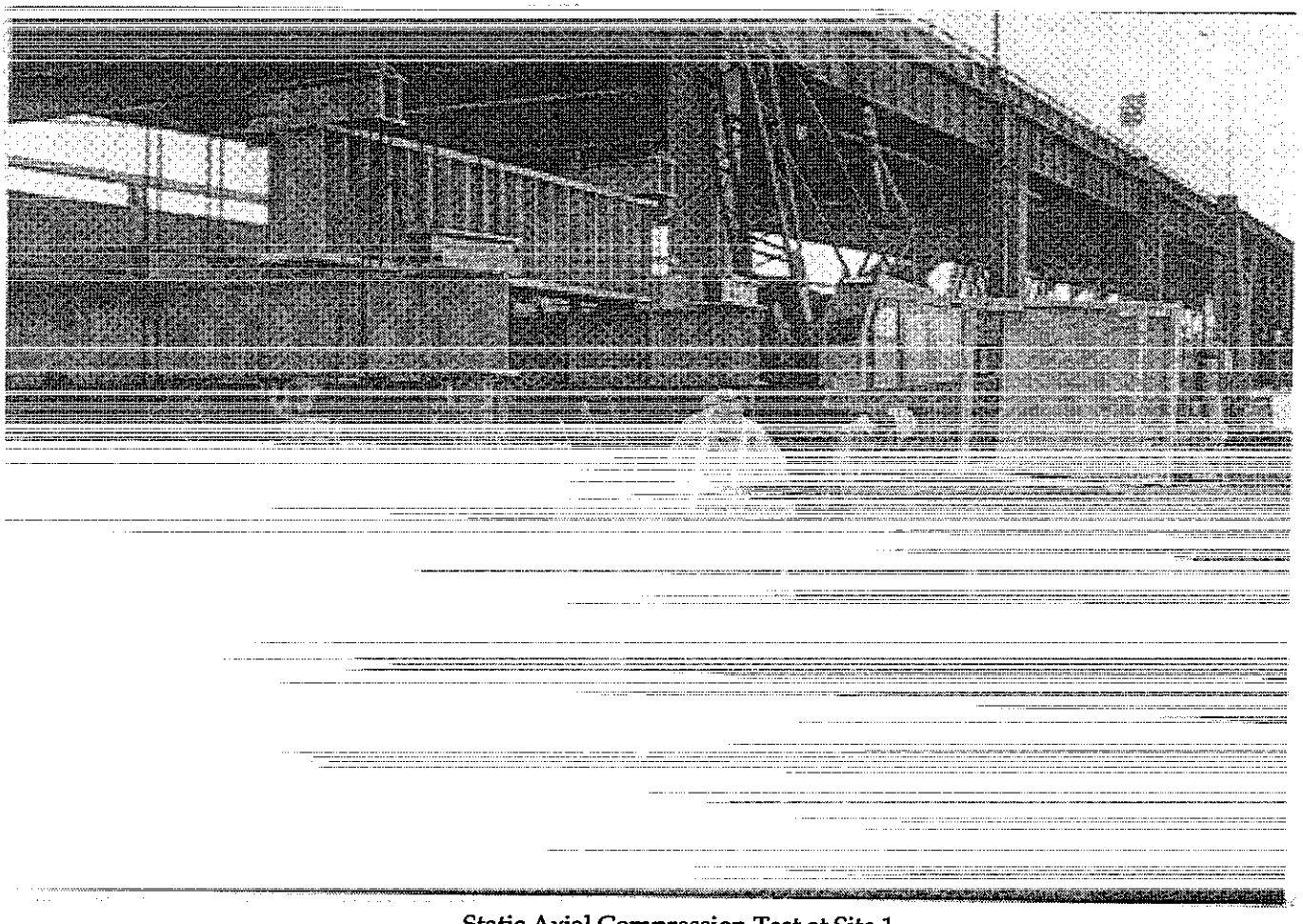
PIL	TIME	CROWD PRES.	TORQUE	GROUT PRES.	GROUT Batch	NOTES
3	11:46	10	40	5		11:46 stop to weld at 53.7', 13:29 restart
4	13:29	30	40	5		
5		30	40	5		
6		30	40	5		
7	13:30	30	40	5		
8		30	40	5		13:30 Reset table
9	13:32	30	40	5		
0		30	40	5		
1		30	40	5		
2	13:33	30	40	5		
3	13:34	30	40	5		Reset table, 13:34 stop to weld, 15:29 restart
4	15:30	20	40	5		
5		20	40	5		
6		20	40	10	1	Start pumping grout
7	15:31	20	40	10		
8		20	40	10		Reset table
9	15:33	20	40	10		
0	15:34	20	40	10		
1		40	40	10		
2	15:35	40	40	10	2	Start pumping grout batch 2 at 72.5'
3	15:36	40	40	10		Reset table
4	15:40	40	40	10		
5	15:43	40	40	10	3	15:43 start pumping grout batch 3
6	15:50	0	30	13	4	Purposely drilling slowly during grouting
7	15:53	40	80	0		end of grout 15:52 start crowd presssure to seat pile

INDICATOR PILE TEST PROGRAM
FOR THE SEISMIC RETROFIT
OF THE EAST APPROACH STRUCTURE OF THE
SAN FRANCISCO - OAKLAND BAY BRIDGE
OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

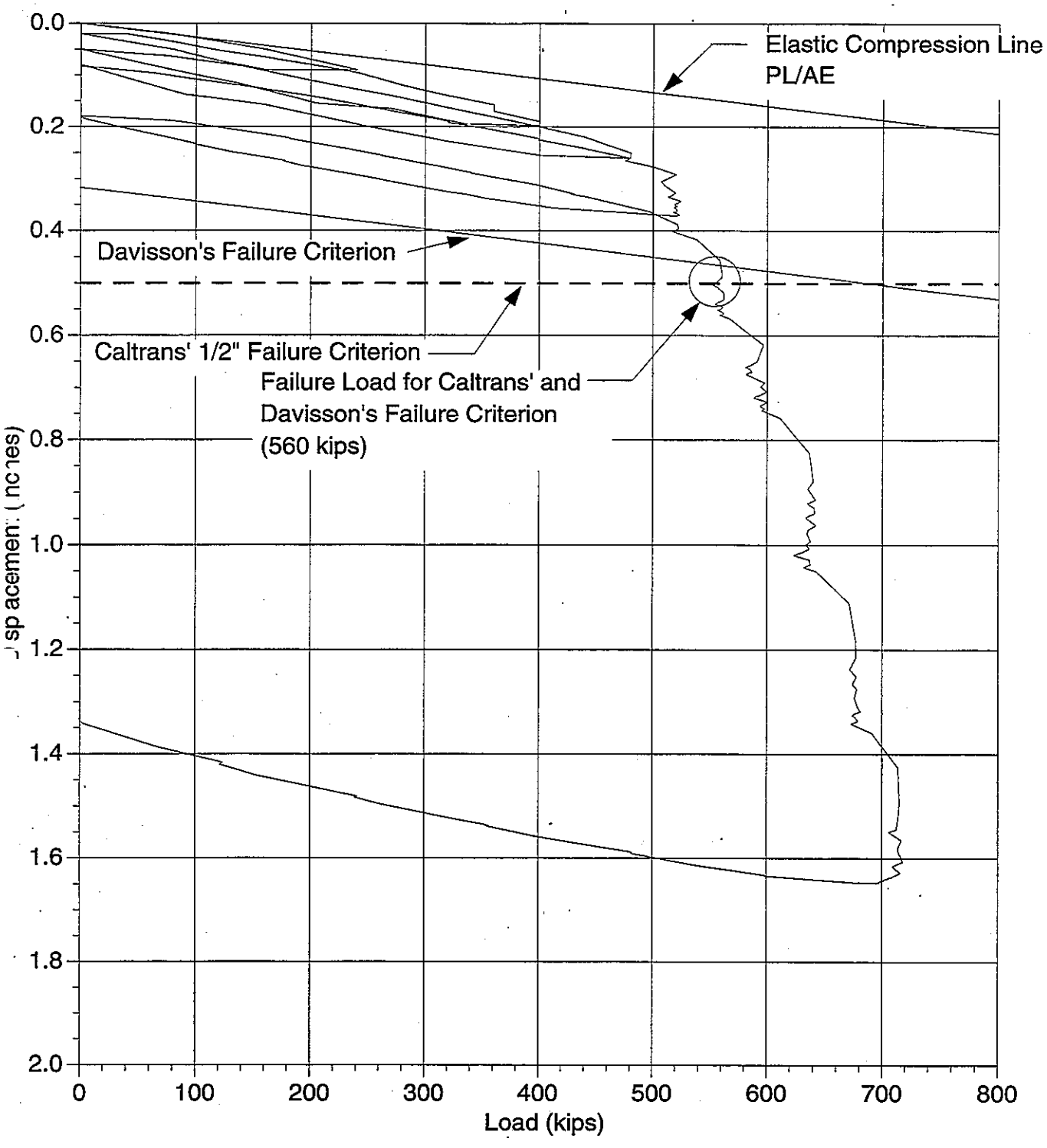
Appendix D

Axial Static Load Test Plots



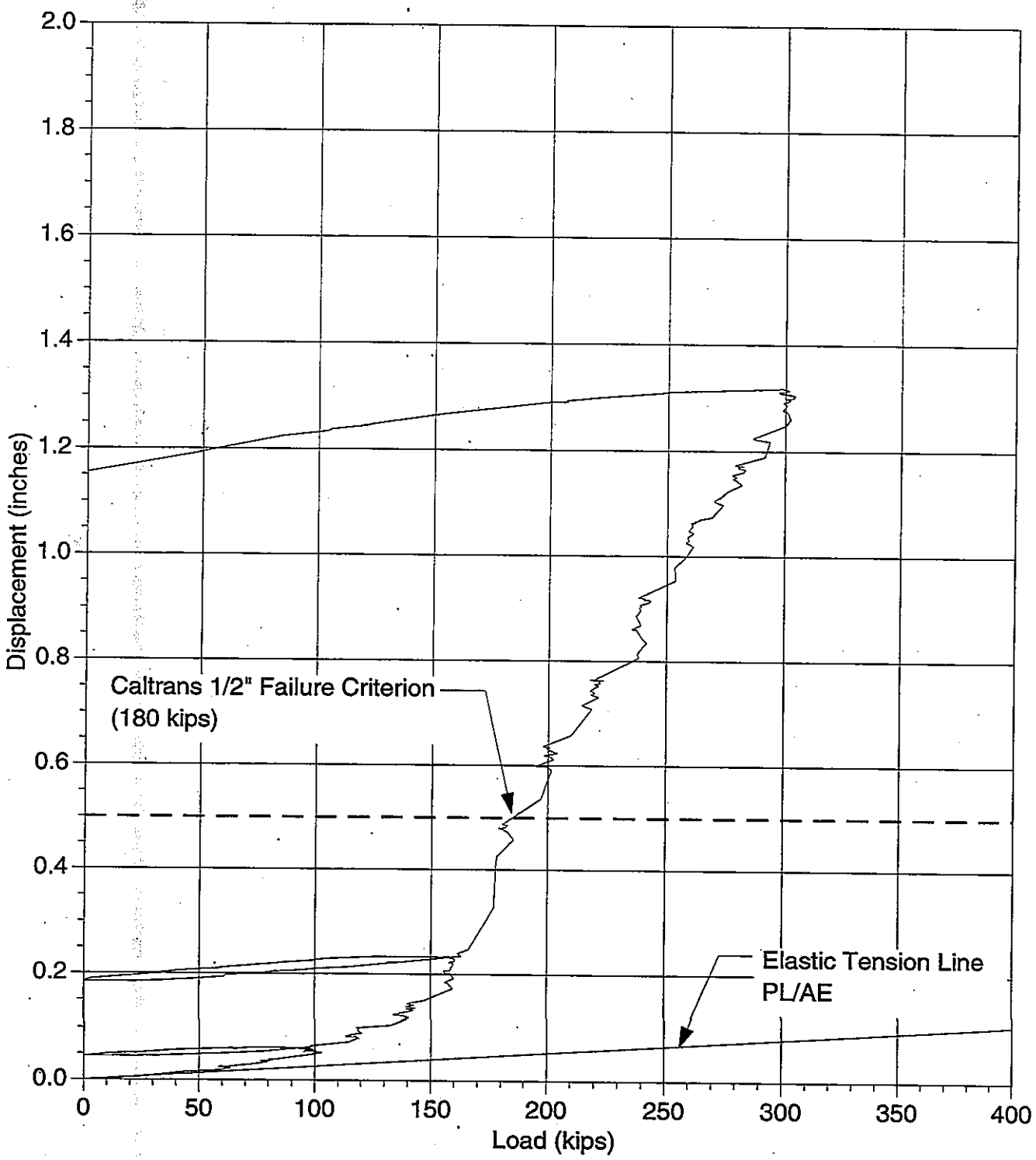
Static Axial Compression Test at Site 1

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995



Static Compression Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 5

Installation Date 11/16/94 — Date Tested 12/9/94
04-Ala-80-1.0/1.3 — 04-043493 — Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" — Ground Surface El. +10 ft
Bottom of Casing El. -10 ft — Pile Tip El. -35.2 ft, Spec Tip El. -40 ft

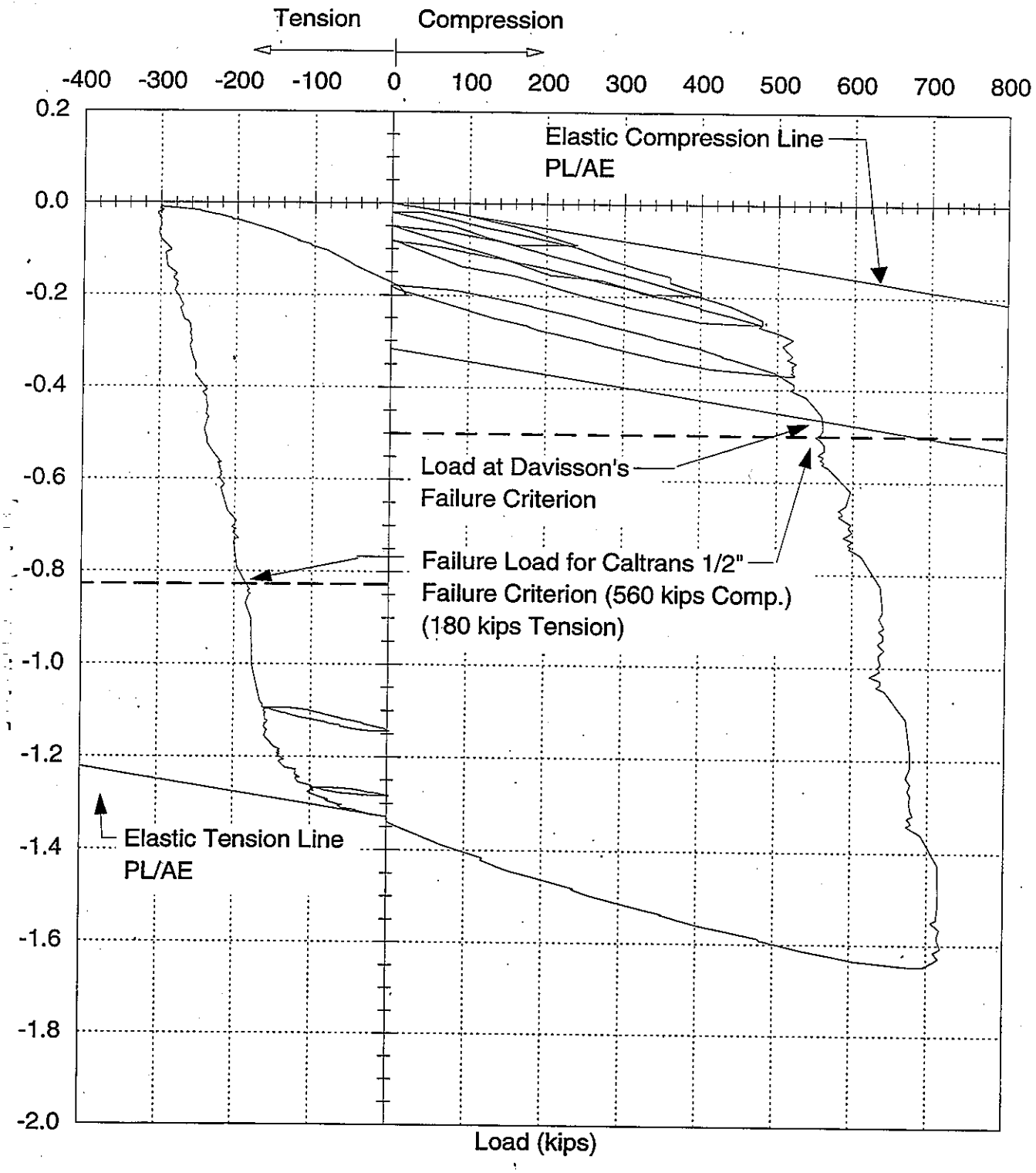


Static Tension Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 5

Installation Date 11/16/94
04-Ala-80-1.0/1.3
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -10 ft

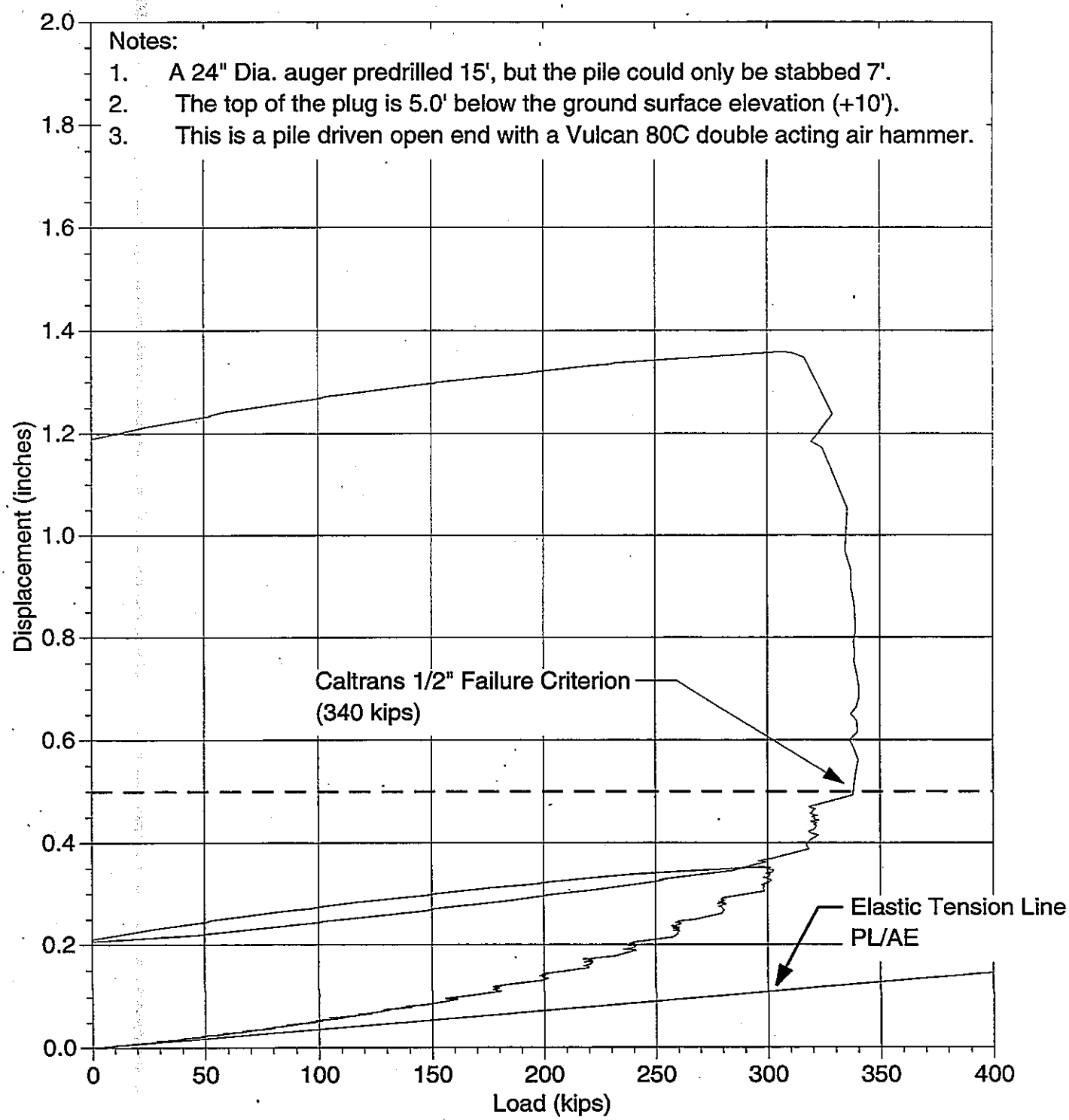
04-043493

Date Tested 12/12/94
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -35.2 ft, Spec Tip El. -40 ft



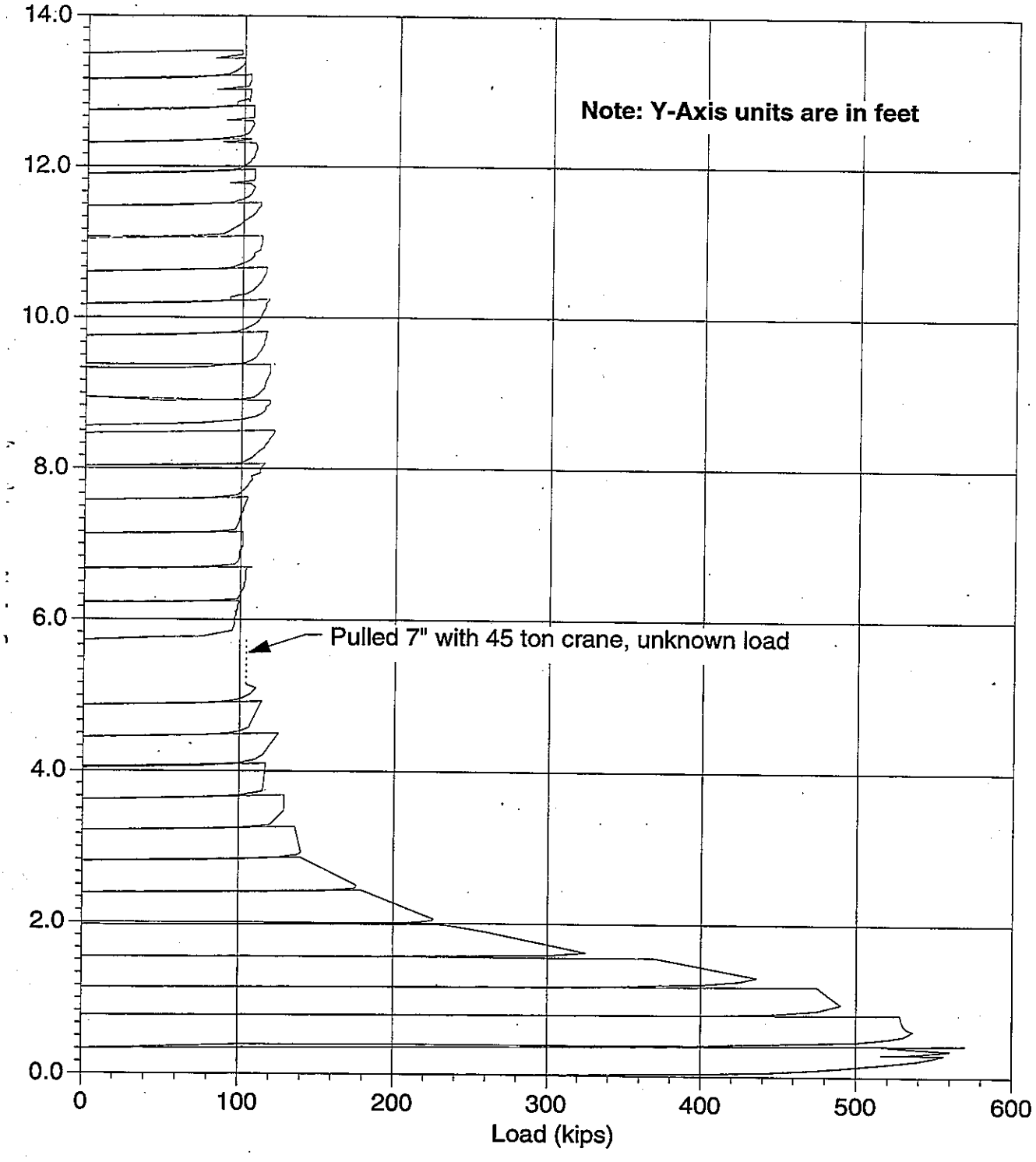
Load Displacement Behavior
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 5

Installation Date 11/16/94 Compression Test 12/9/94 Tension Test 12/12/94
04-Ala-80-1.0/1.3 04-043493 Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" Ground Surface El. +10 ft
Bottom of Casing El. -10 ft Pile Tip El. -35.2 ft, Spec Tip El. -40 ft



Static Tension Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 6

Installation Date 12/22/94 — Date Tested 12/28/94
04-Ala-80-1.0/1.3 — 04-043493 — Bridge No. 33-25
Driven PP24" x 0.75" — Ground Surface El. +10 ft
Depth of 24" Dia. Predrill is 15' — Pile Tip El. -40 ft, Spec Tip El. -40 ft

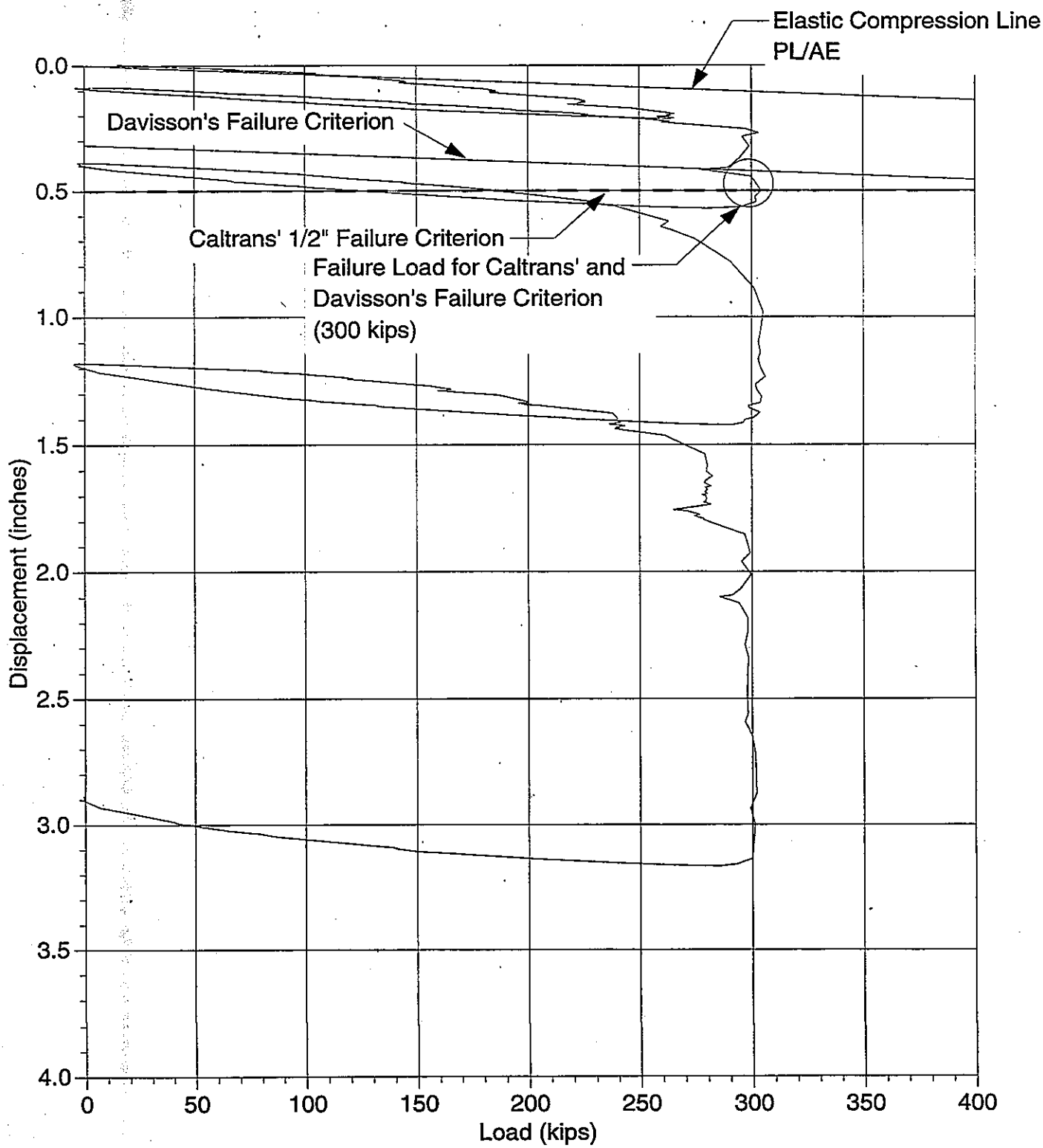


Pile Extraction
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 1, Pile 5

Installation Date 11/16/94
04-Ala-80-1.0/1.3
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -10 ft

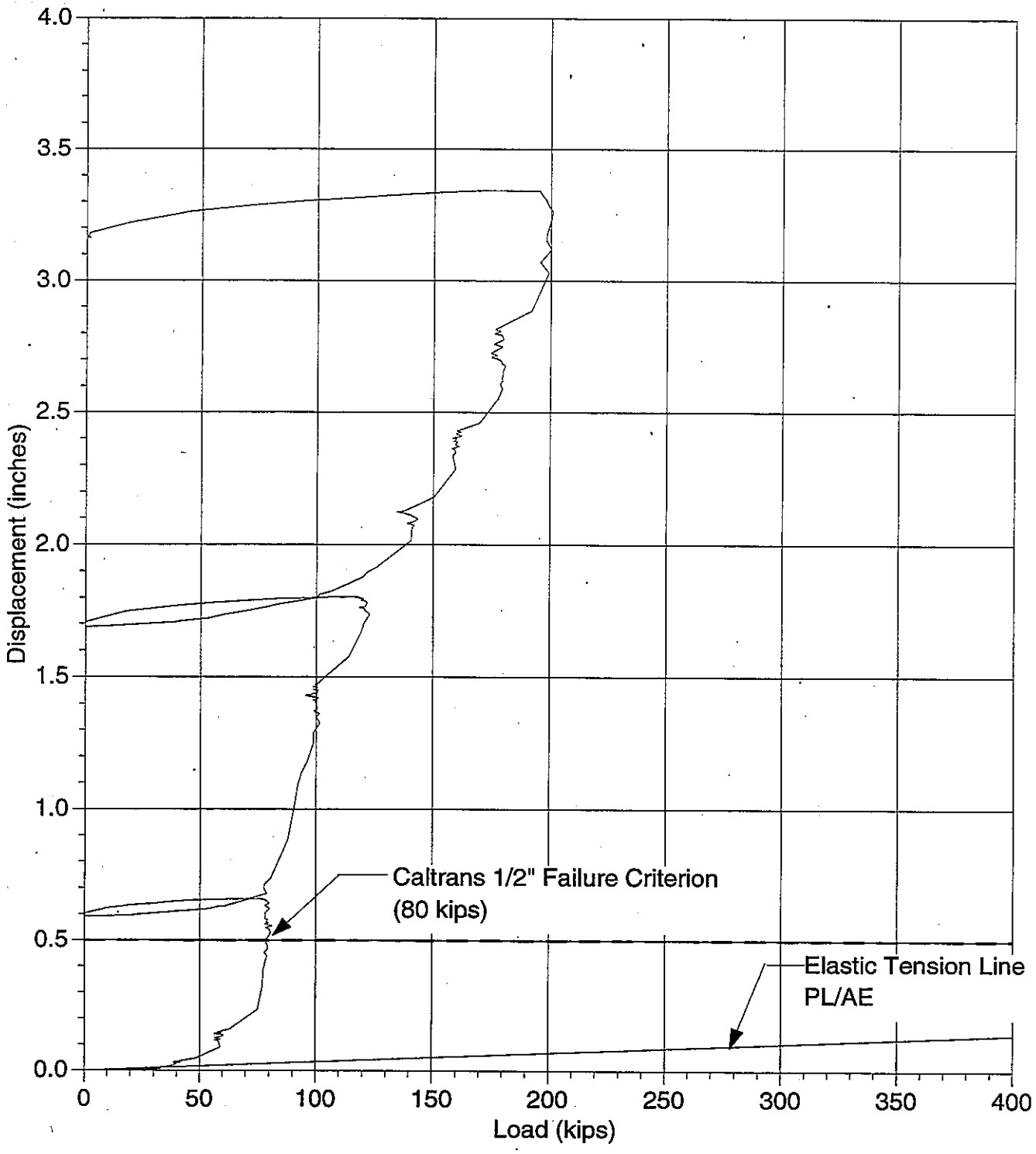
04-043493

Date Extracted 1/4/94
Bridge No. 33-25
Ground Surface El. +10 ft
Pile Tip El. -35.2 ft, Spec Tip El. -40 ft



Static Compression Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 5

Installation Date 11/29-30/94 — Date Tested 12/21/94
04-Ala-80-1.0/1.3 — 04-043493 — Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" — Ground Surface El. +14 ft
Bottom of Casing El. -14 ft — Pile Tip El. -45 ft, Spec. Tip El. -45 ft

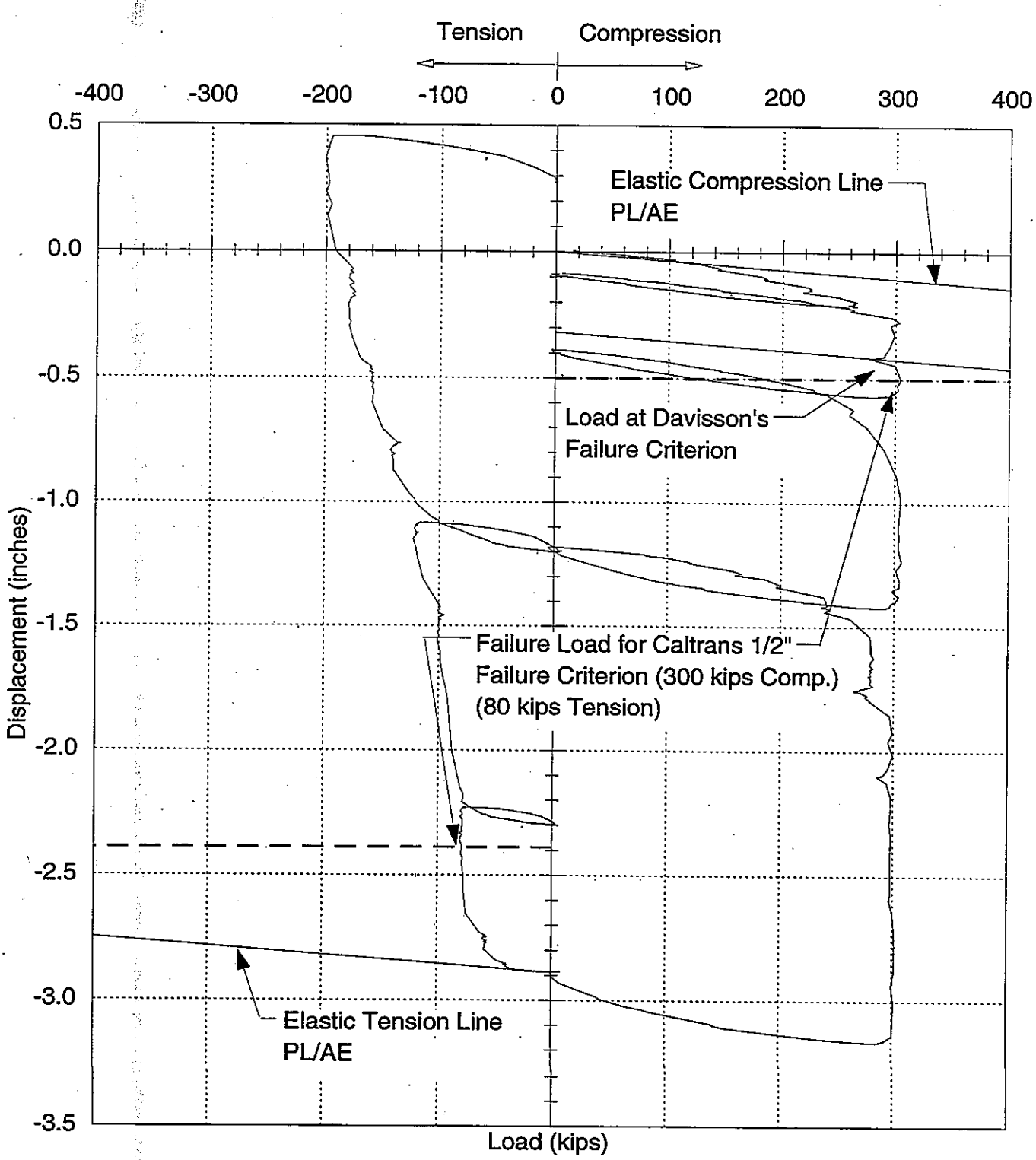


Static Tension Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 5

Installation Date 11/29-30/94
04-Ala-80-1.0/1.3
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -14 ft

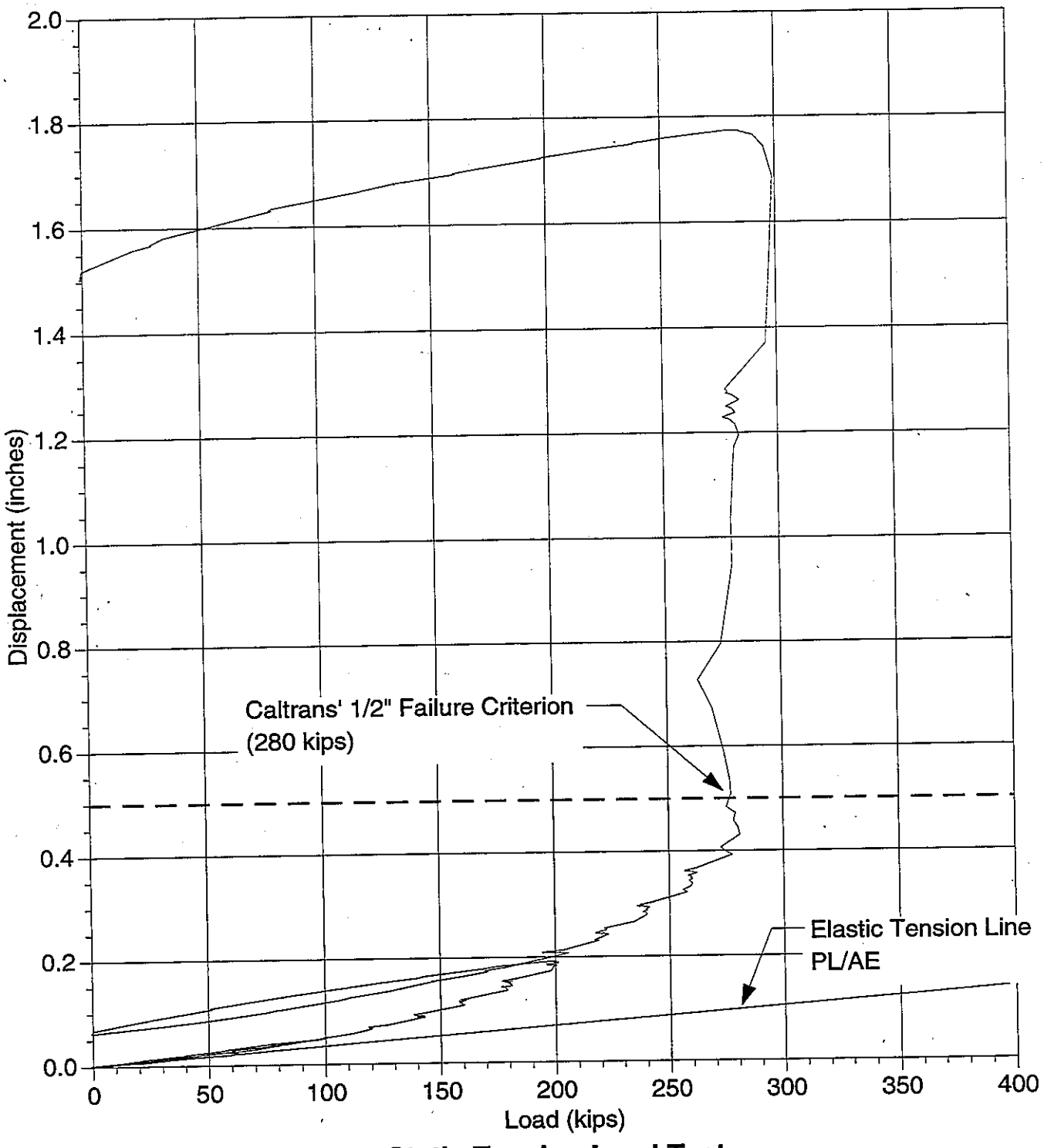
04-043493

Date Tested 12/22/94
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45 ft, Spec Tip El. -45 ft



Load Displacement Behavior
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 5

Installation Date 11/29-30/94 Comp. Test 12/21/94 Tension Test 12/22/94
04-Ala-80-1.0/1.3 04-043493 Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" Ground Surface El. +14 ft
Bottom of Casing El. -14 ft Pile Tip El. -45 ft, Spec Tip El. -45 ft

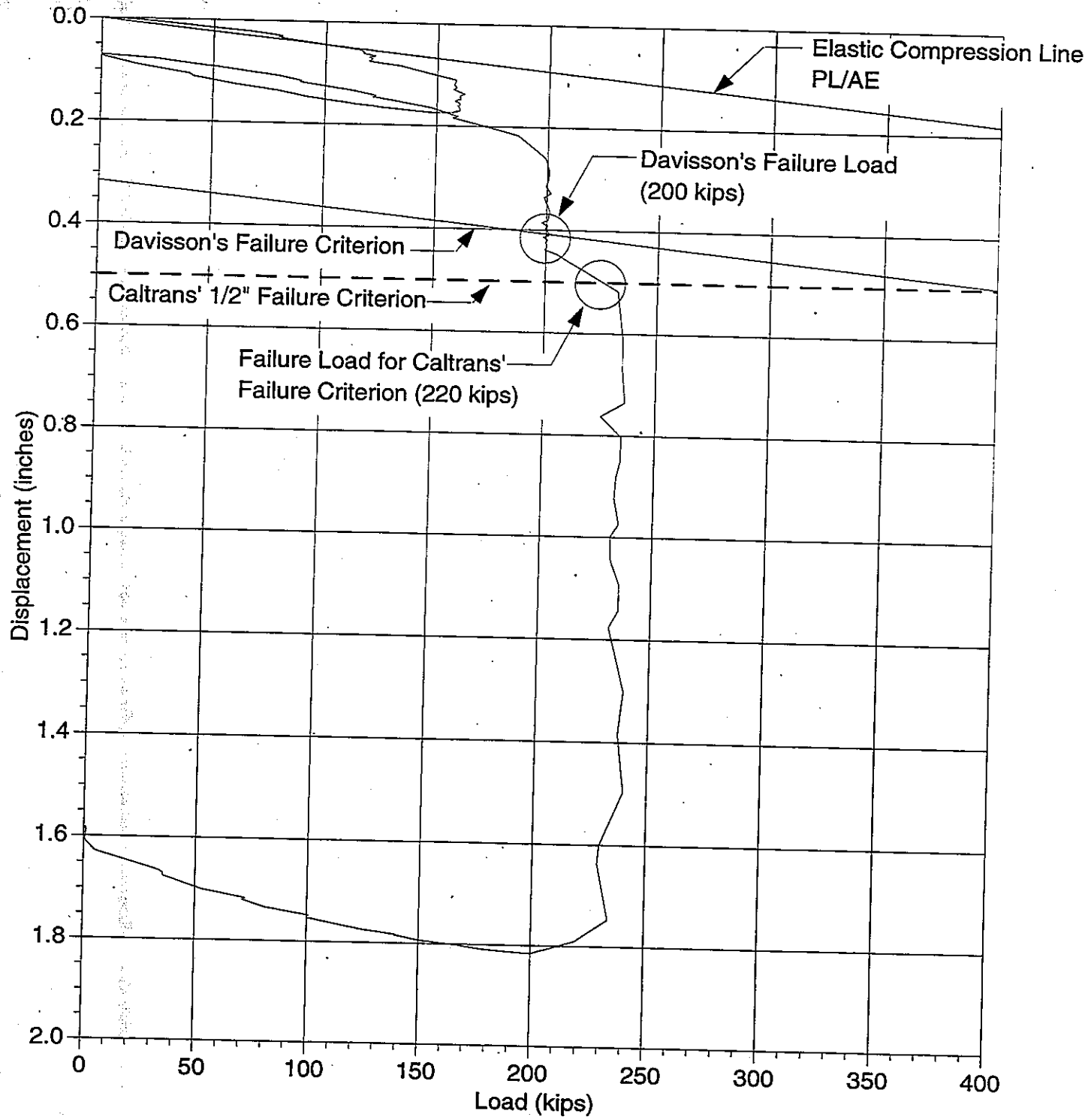


Static Tension Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 2, Pile 4

Installation Date 11/28/94
04-Ala-80-1.0/1.3
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -14 ft

04-043493

Date Tested 1/3/95
Bridge No. 33-25
Ground Surface El. +14 ft
Pile Tip El. -45.2 ft, Spec Tip El. -45 ft

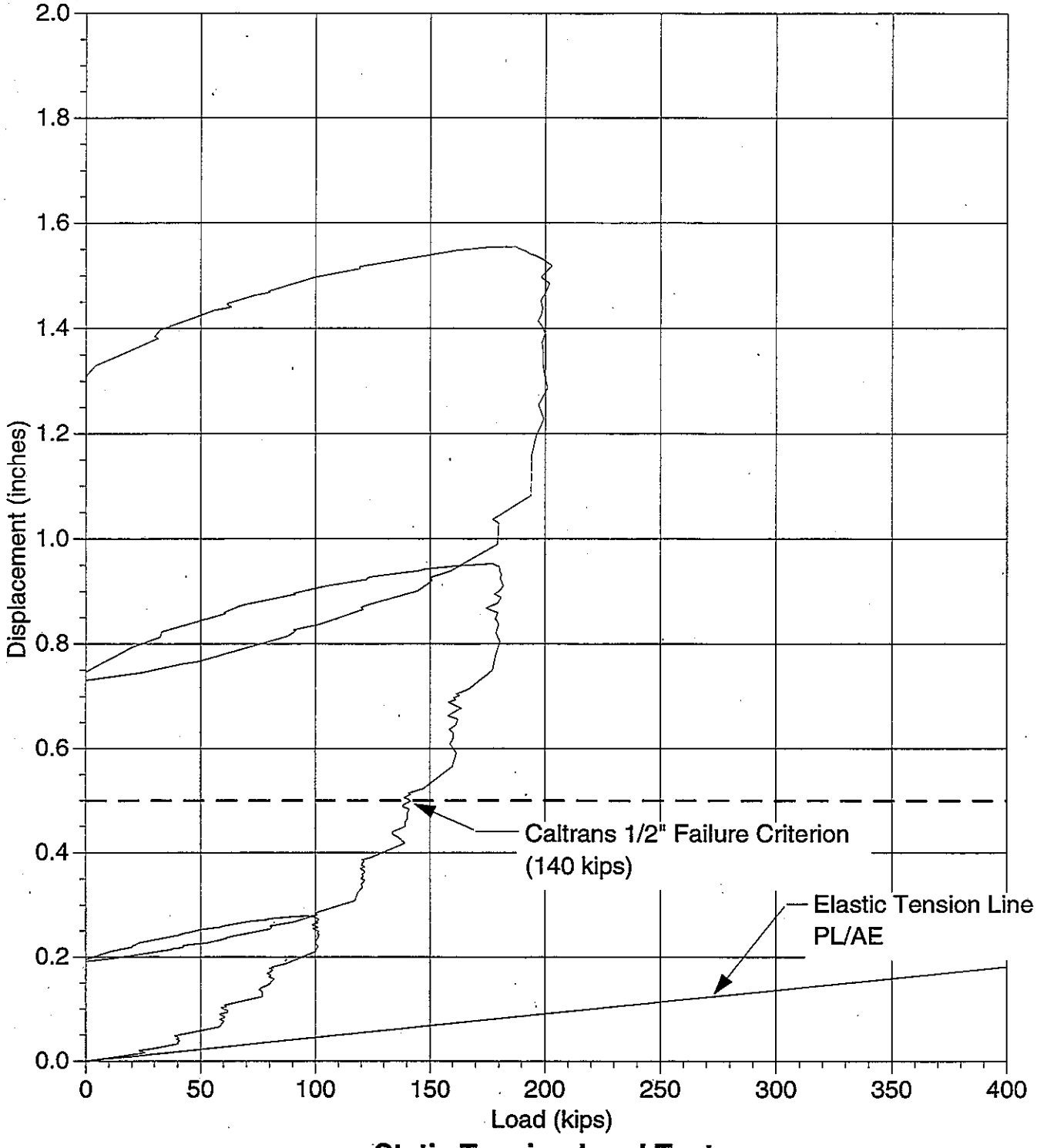


Static Compression Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 5

Installation Date 12/7/94
04-Ala-80-1.0/1.3
PP20" x 0.5" and PP20" x 0.75"
Bottom of Casing El. -15 ft

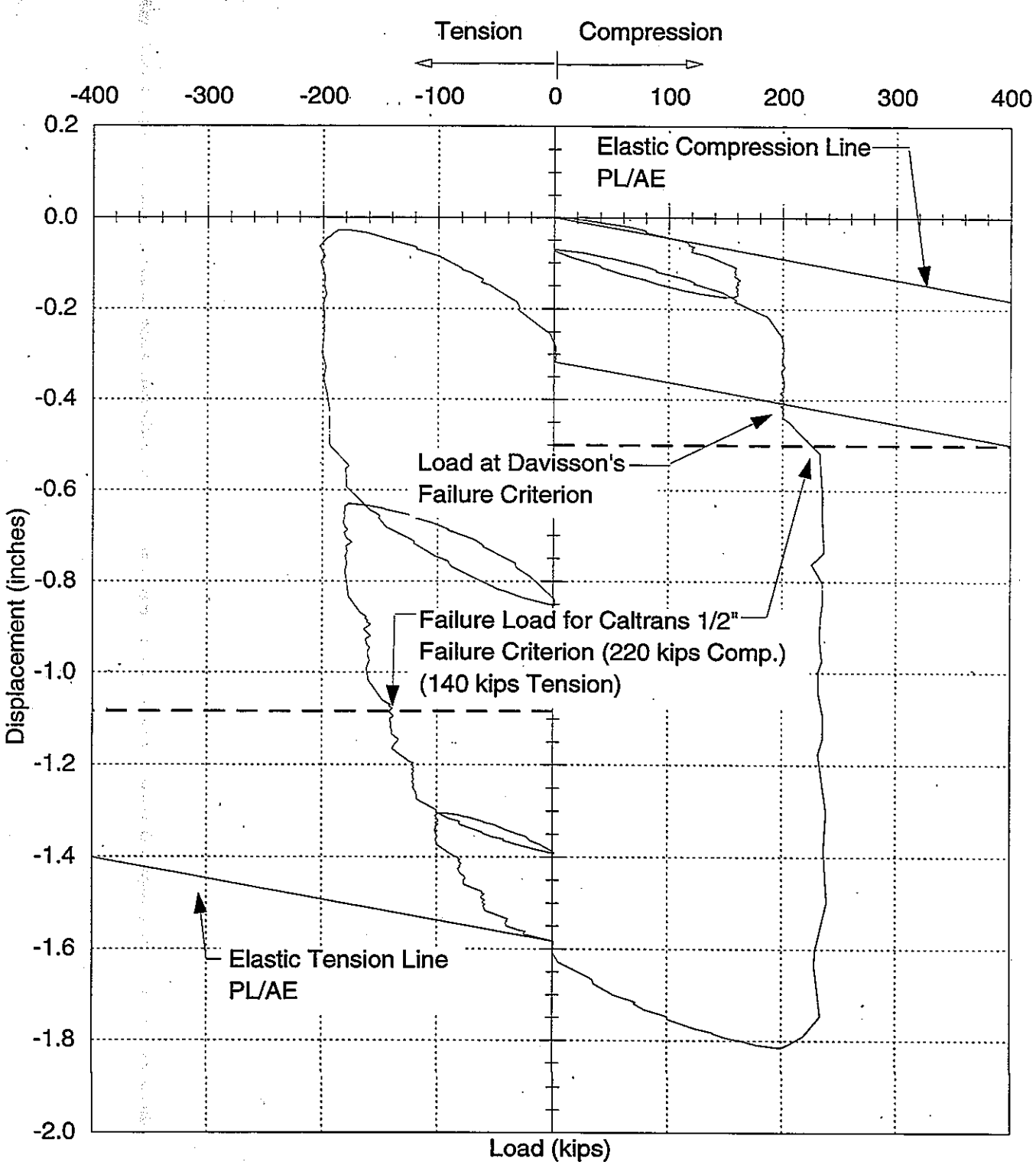
04-043493

Date Tested 12/27/94
Bridge No. 33-25
Ground Surface El. +12 ft
Pile Tip El. -65 ft, Spec Tip El. -65 ft



Static Tension Load Test
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 5

Installation Date 12/7/94 — Date Tested 12/27/94
04-Ala-80-1.0/1.3 — 04-043493 — Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" — Ground Surface El. +12 ft
Bottom of Casing El. -15 ft — Pile Tip El. -65 ft, Spec Tip El. -65 ft

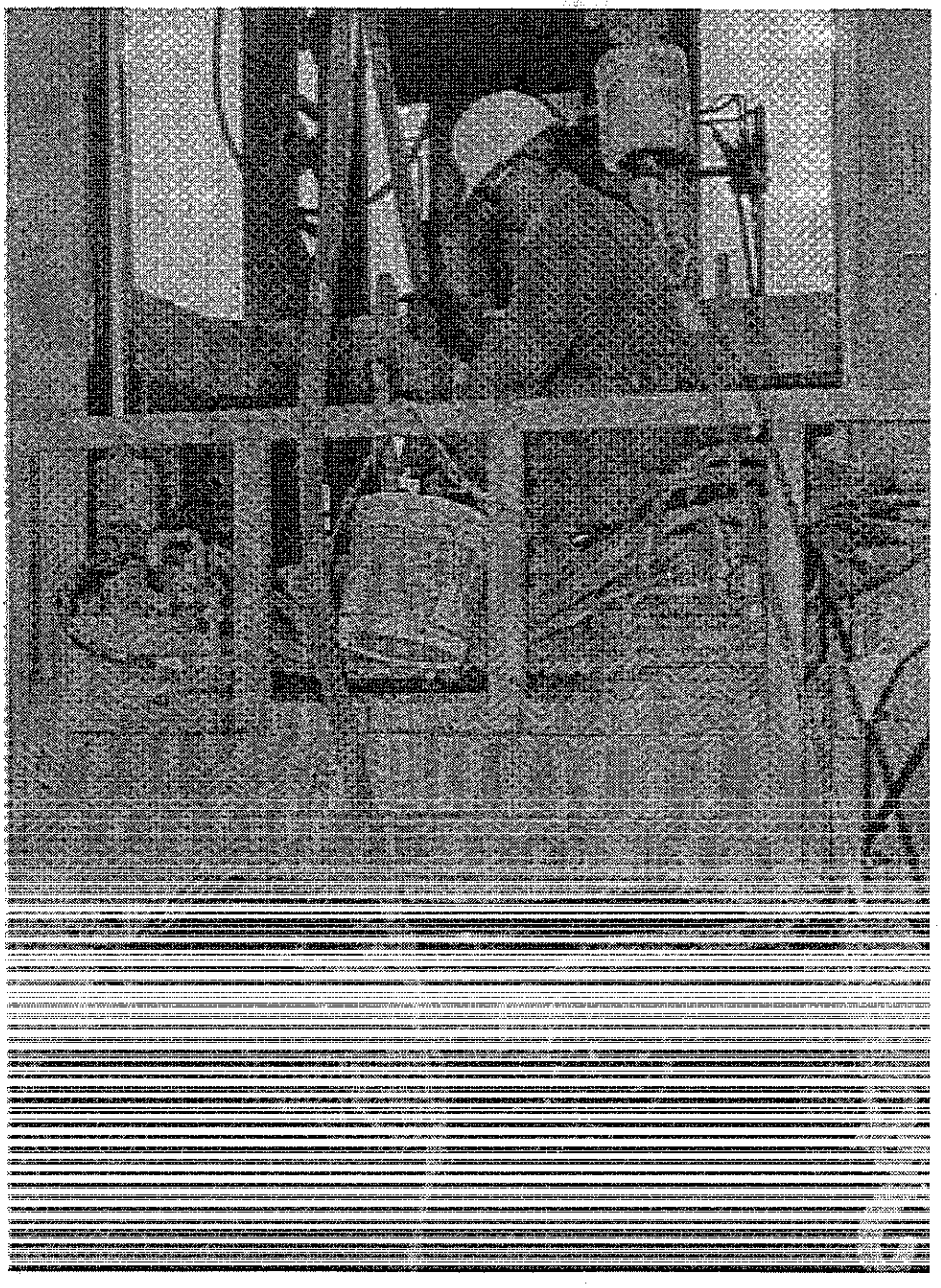


Load Displacement Behavior
San Francisco-Oakland Bay Bridge
Indicator Pile Test Program
Site 3, Pile 5

Installation Date 12/7/94 Compression Test 12/27/94 Tension Test 12/27/94
04-Ala-80-1.0/1.3 04-043493 Bridge No. 33-25
PP20" x 0.5" and PP20" x 0.75" Ground Surface El. +12 ft
Bottom of Casing El. -15 ft Pile Tip El. -65 ft, Spec Tip El. -65 ft

INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

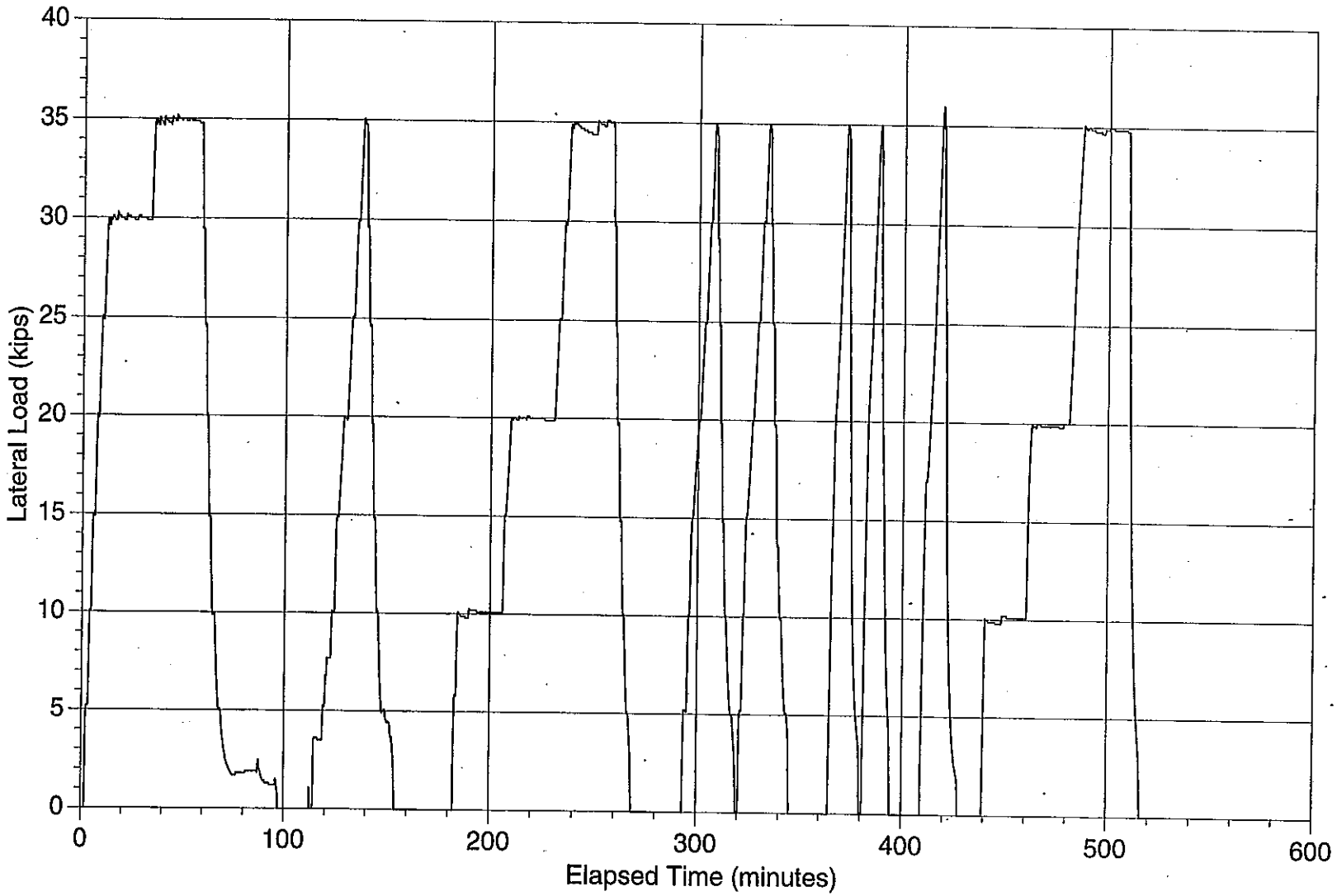


Appendix E

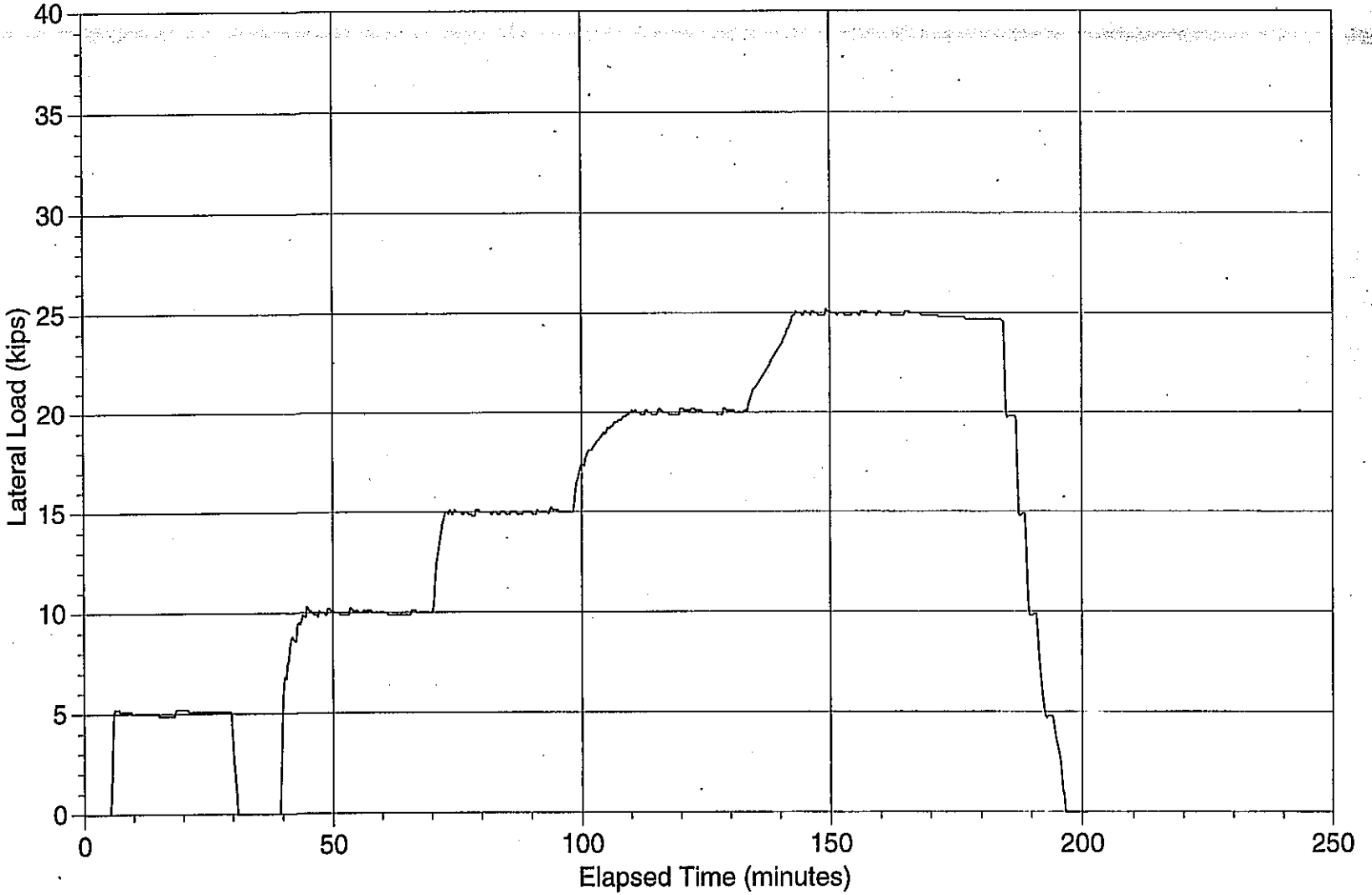
Site 1
Piles 1 and 2
Lateral Load Test Plots

Removing the swivel head for the grout pipe in order to splice during pile installation

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995



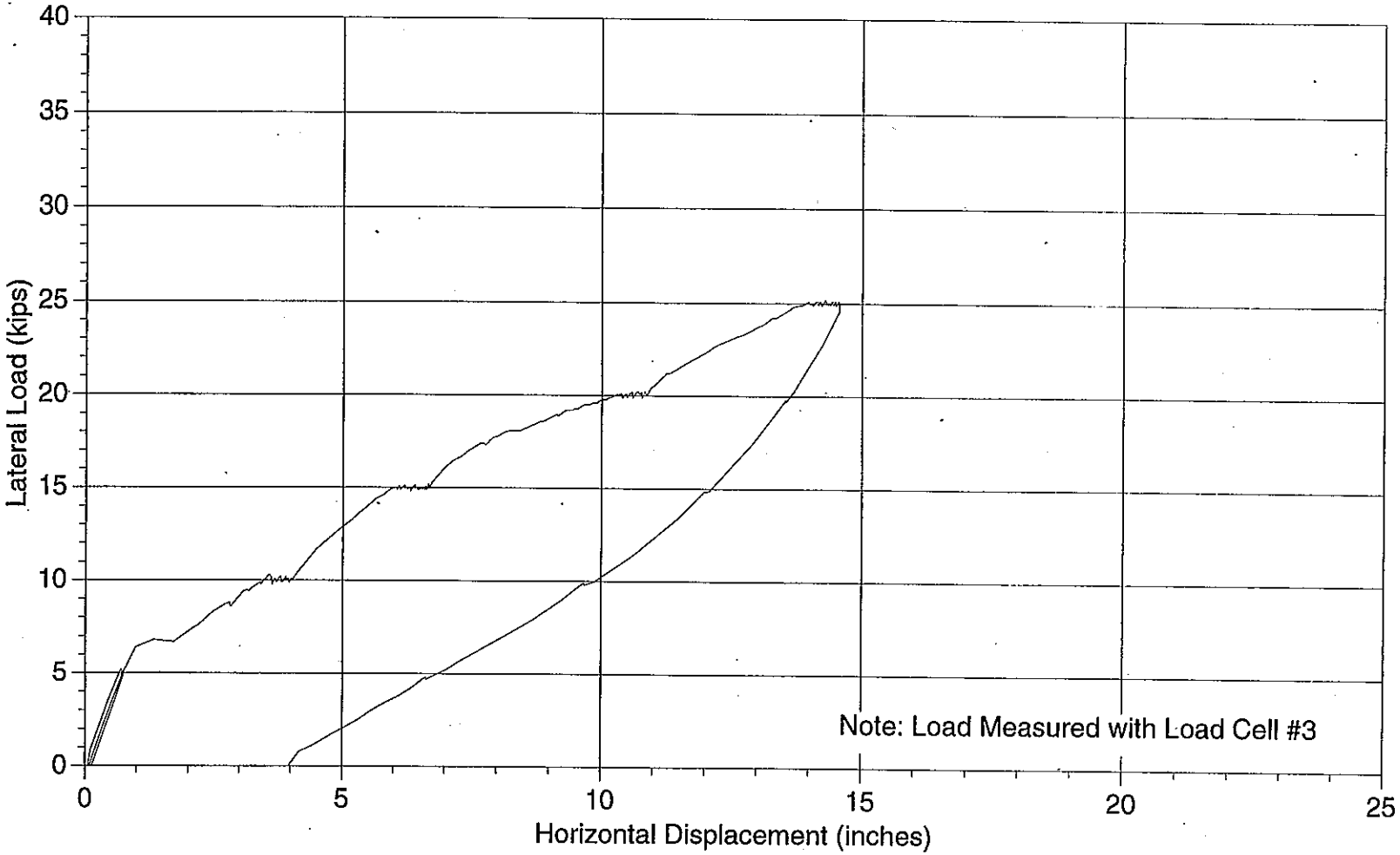
Lateral Load - Time History
Test Site 1, Pile 1 and Pile 2
Test 2, Test Date: 12/2/94



Lateral Load - Time History

Test Site 1, Pile 1 and Pile 2

Test 1, Test Date: 12/1/94



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/16/94

Date Tested: 12/1/94

Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

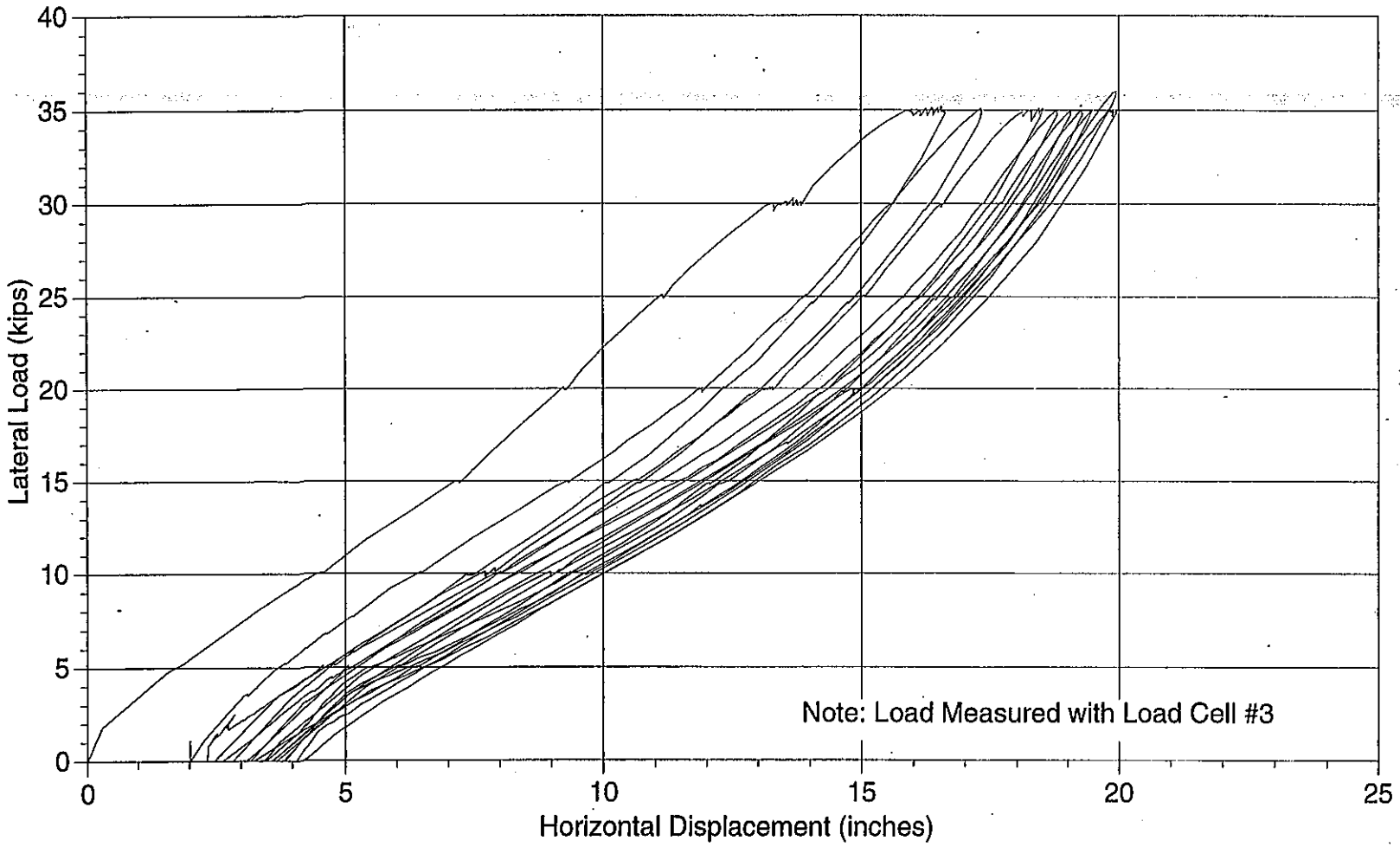
Pile Tip Elevation: -37.5 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -8.2 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 1 (Test 1)



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/16/94

Date Tested: 12/2/94

Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

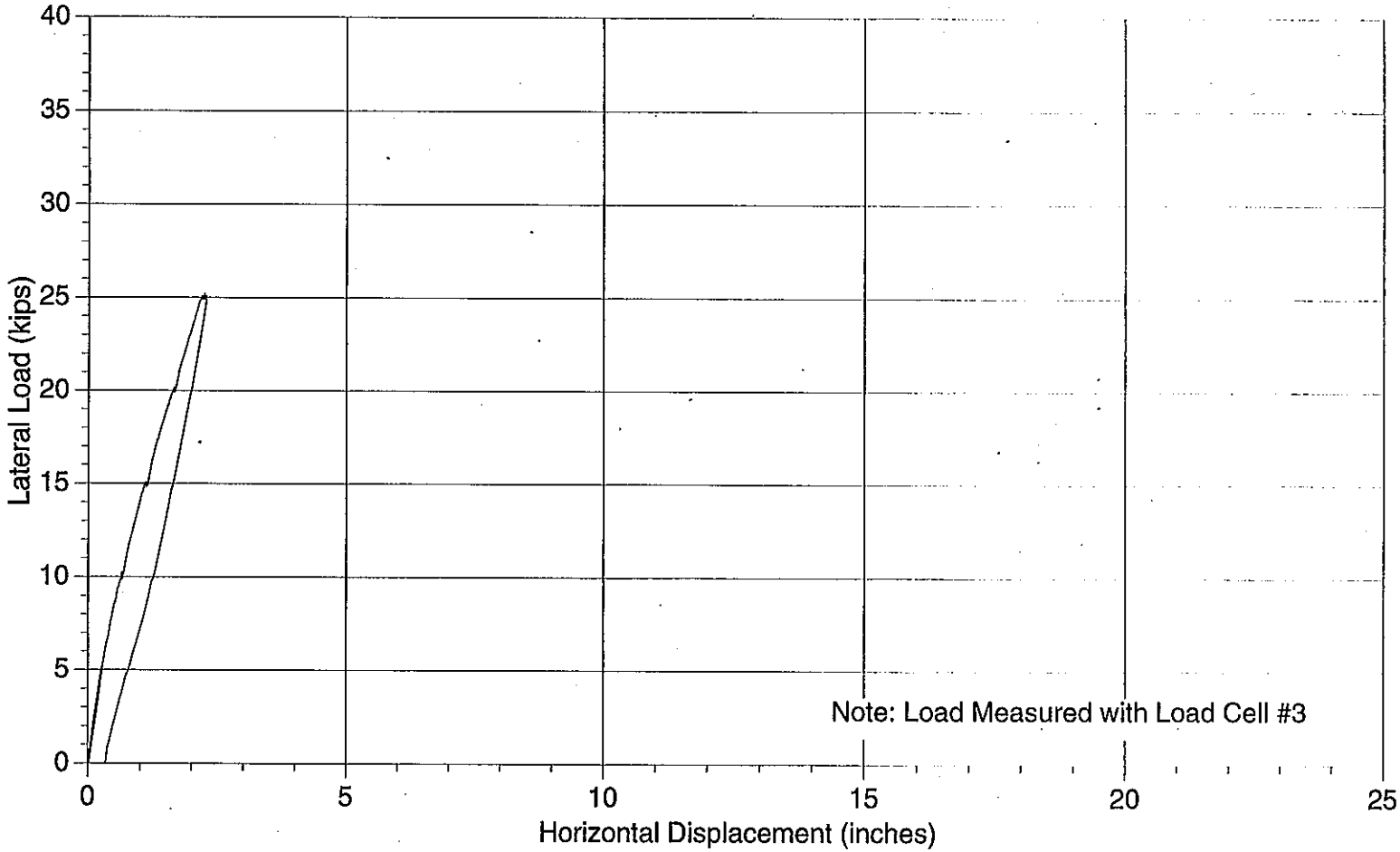
Pile Tip Elevation: -37.5 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -8.2 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 1 (Test 2)



Pile Type: Fundex PP 20x0.5

Grout Volume: 720 gallons

Date Installed: 11/17/94

Date Tested: 12/1/94

Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

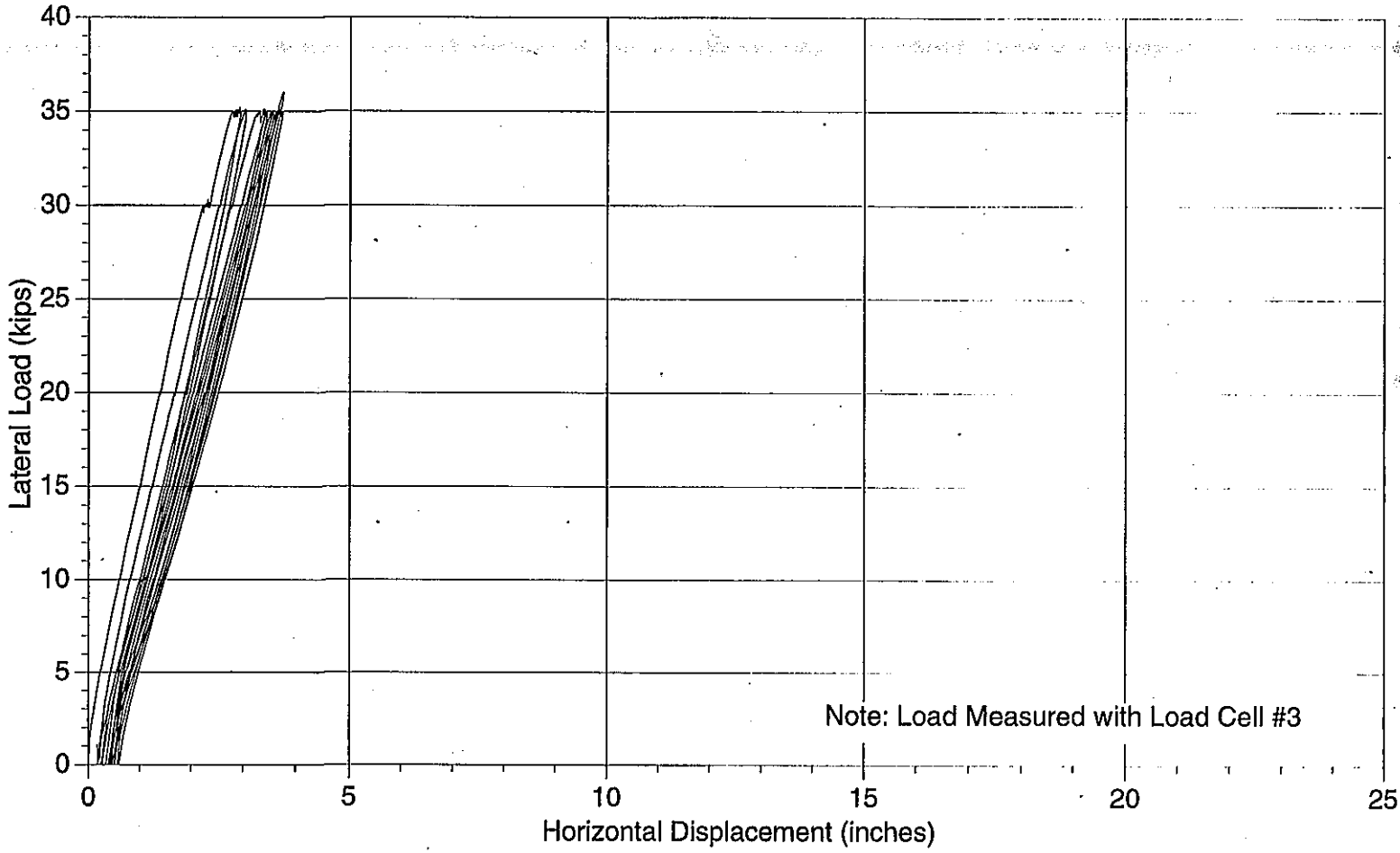
Pile Tip Elevation: -39.0 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -1.3 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 2 (Test 1)



Pile Type: Fundex PP 20x0.5

Grout Volume: 720 gallons

Date Installed: 11/17/94

Date Tested: 12/2/94

Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

Pile Tip Elevation: -39.0 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -1.3 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 2 (Test 2)

Summary of Slope Inclinometer Reading Events
Test Site 1, Pile 1

Test Date 12/1/94 and 12/2/94

Slope Inclinometer Serial Number: 25864

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-17.38	1.32		
1	0	0.0			-20.38	0.95		
1	5	4.3	0.70	0.76	-20.96	1.70	0.75	4.04
1	10	8.7	3.40	4.02	-24.46	2.96	2.01	6.46
1	15	13.3	5.99	6.69	-28.21	4.61	3.66	8.21
1	20	18.2	9.32	10.87	-28.04	4.77	3.82	10.04
1	25	23.2	13.82	14.57	-27.00	3.20	2.25	7.00
1	0	0.0	3.96	3.67	-17.00	4.17	3.22	9.00
Test Continued on 12/2/94								
2	0	0.0			-12.96	1.84		
2	0	0.0			-15.21	1.68		
2	30	27.1	13.30	13.84	-21.46	3.25	2.30	7.46
2	35	32.8	16.62	16.63	-22.04	4.35	3.40	7.96
2	0	0.0	0.23	2.01	-10.25	6.83	5.88	12.25
4	0	0.0	2.65	2.37	-17.17	1.03	0.08	2.83
4	10	12.5	7.69	7.91	-20.38	4.01	3.06	7.63
4	20	21.9	12.14	13.29	-19.46	1.26	0.31	2.54
4	35	36.6	17.52	18.51	-23.50	3.88	2.93	7.50
4	0	0.0	3.83	2.74	-16.50	1.55	0.61	3.50
10	10	7.2	8.99	9.16	-25.71	3.69	2.74	6.29
10	20	15.9	14.83	15.01	-20.17	1.97	1.02	5.17
10	35	30.6	19.84	19.97	-22.29	2.24	1.30	4.29

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-9.83	3.98		
1	0	0.0			-7.29	5.78		
1	5	4.3	-0.06		-6.42	5.14	4.19	10.58
1	10	8.7	0.54		-6.50	6.60	5.65	21.50
1	15	13.3	0.24		-5.75	4.37	3.42	10.75
1	20	18.2	-0.06		-5.92	3.94	2.99	9.08
1	25	23.2	-0.46		-6.58	4.49	3.54	12.58
1	0	0.0	-0.01		-5.96	4.38	3.43	10.04
Test Continued on 12/2/94								
2	0	0.0			0.25	4.12		
2	0	0.0			-1.21	4.72		
2	30	27.1	-0.72		-7.50	4.45	3.50	8.50
2	35	32.8	-0.78		-6.13	3.89	2.94	8.13
2	0	0.0	-0.22		-4.33	4.72	3.77	9.33
4	0	0.0	-0.30	-0.30	-6.29	4.06	3.11	9.29
4	10	12.5	-0.60	-0.60	-5.79	4.72	3.77	13.79
4	20	21.9	-0.96	-0.96	-6.46	4.48	3.53	8.46
4	35	36.6	-1.20	-1.20	-6.29	5.31	4.36	16.29
4	0	0.0	-0.36	-0.36	-8.75	4.20	3.25	8.75
10	10	7.2	-0.81	-0.84	-10.13	3.93	2.98	7.13
10	20	15.9	-1.08	-1.08	-8.75	3.71	2.76	7.25
10	35	30.6	-1.38	-1.44	-10.50	3.79	2.84	8.50

Summary of Slope Inclinometer Reading Events
Test Site 1, Pile 2

Test Date 12/1/94 and 12/2/94

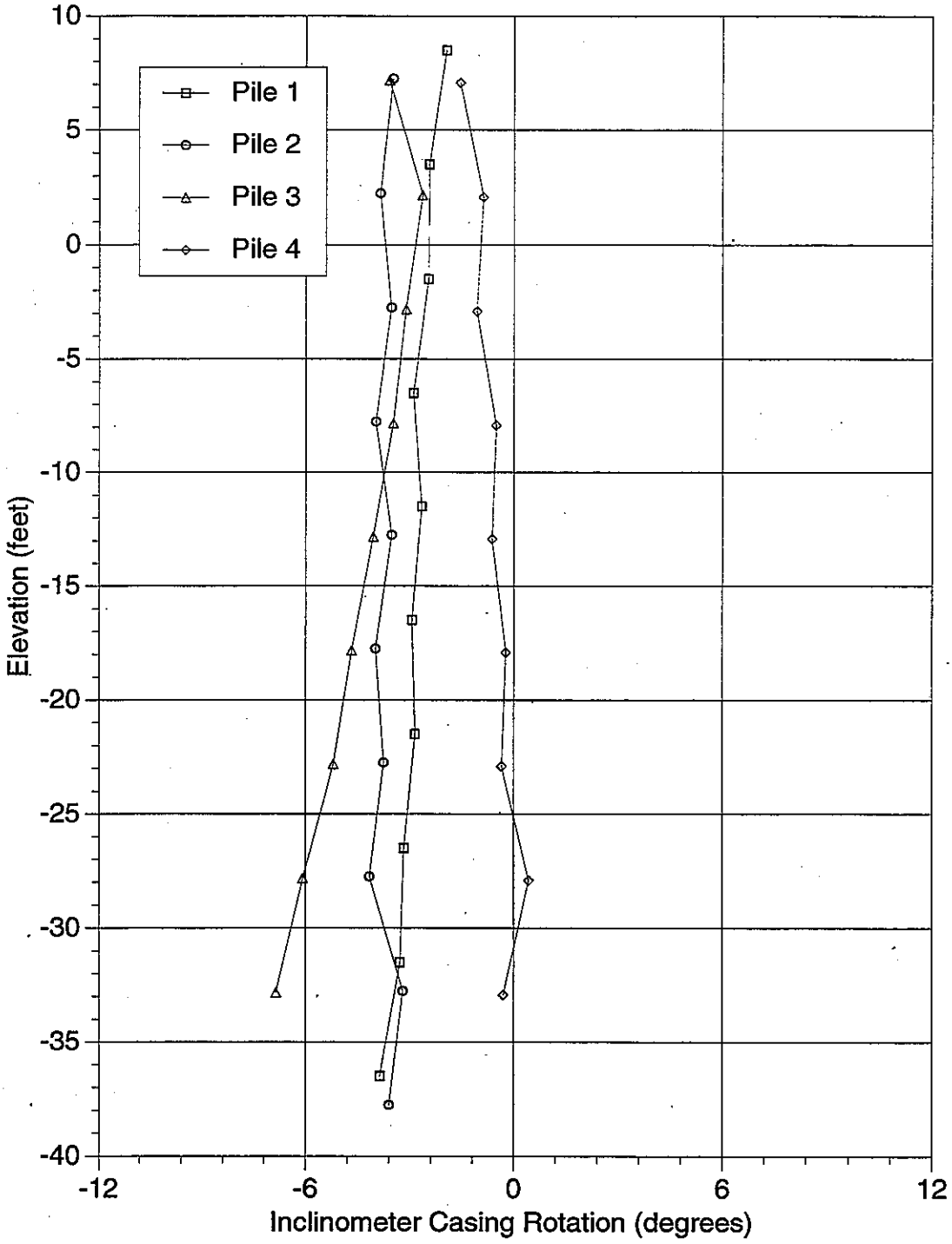
Slope Inclinometer Serial Number: 25690

Measurements in Direction of Applied Lateral Load (A-Direction)

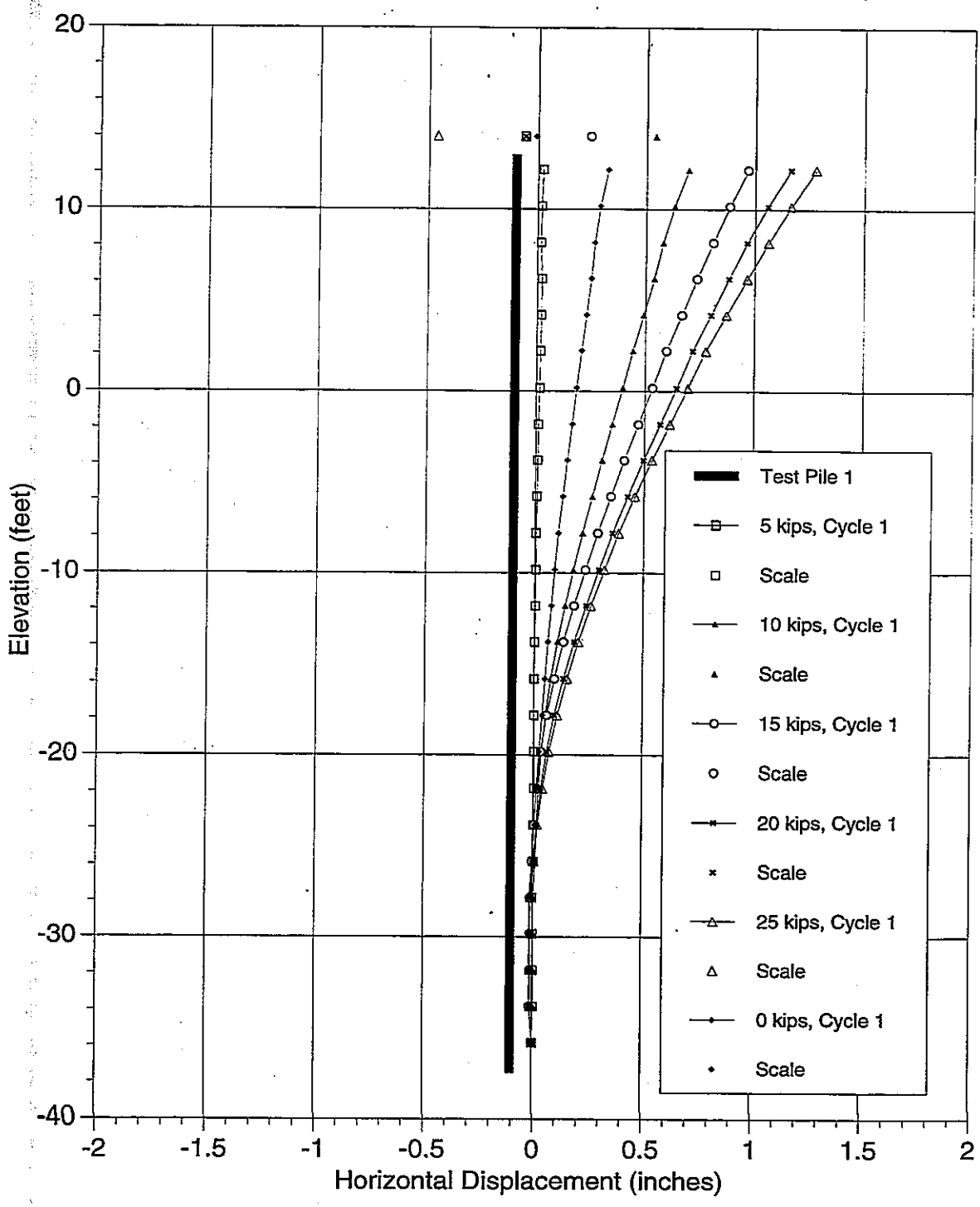
Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-0.96	2.85		
1	0	0.0			-1.72	3.16		
1	5	5.1	0.27	0.28	-1.12	2.86	0.30	8.88
1	10	10.0	0.62	0.67	-1.21	2.53	0.62	6.79
1	15	15.0	1.08	1.14	-2.08	2.77	0.39	8.92
1	20	19.9	1.53	1.68	-2.33	3.79	0.64	10.67
1	25	24.9	2.17	2.28	-3.63	2.63	0.53	8.38
1	0	0.0	0.34	0.31	-1.42	2.93	0.23	7.42
Test Continued on 12/2/94								
2	0	0.0			0.54	2.74		
2	0	0.0			-0.38	3.03		
2	30	30.0	2.23	2.35	-0.92	2.98	0.17	8.08
2	35	34.9	2.82	2.94	-1.83	2.69	0.47	8.17
2	0	0.0	0.23	0.18	1.96	4.73	1.57	10.04
4	0	0.0	0.27	0.23	-1.42	2.22	0.94	6.58
4	10	10.1	1.01	1.02	-2.38	2.58	0.58	4.63
4	20	19.9	1.70	1.92	-1.08	2.43	0.73	5.92
4	35	34.7	3.08	3.41	-3.75	3.93	0.77	10.25
4	0	0.0	0.47	0.33	-0.92	2.52	0.64	6.08
10	10	10.0	1.28	1.29	-1.21	2.57	0.59	7.79
10	20	19.9	2.26	2.28	-2.04	2.32	0.84	6.96
10	35	34.9	3.70	3.75	-2.83	2.48	0.68	6.17

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			34.72	14.13		
1	0	0.0			32.92	13.03		
1	5	5.1	0.02		28.96	13.57	10.42	56.96
1	10	10.0	0.05		27.42	13.75	10.60	56.42
1	15	15.0	0.10		27.04	12.01	8.85	51.04
1	20	19.9	0.14		28.25	13.09	9.94	53.25
1	25	24.9	0.19		28.46	13.29	10.13	57.46
1	0	0.0	0.04		30.08	12.24	9.08	51.08
Test Continued on 12/2/94								
2	0	0.0			32.96	11.40		
2	0	0.0			31.25	12.06		
2	30	30.0	0.42	0.43	31.92	12.77	9.61	53.92
2	35	34.9	0.51	0.54	32.13	12.68	9.52	51.13
2	0	0.0	0.05	0.05	34.17	12.74	9.58	52.17
4	0	0.0	0.07	0.07	36.08	11.92	8.76	50.08
4	10	10.1	0.20	0.20	34.50	12.33	9.17	52.50
4	20	19.9	0.36	0.37	34.33	11.94	8.79	48.33
4	35	34.7	0.67	0.70	33.75	12.81	9.65	49.75
4	0	0.0	0.11	0.11	33.58	13.51	10.36	50.58
10	10	10.0	0.29	0.30	32.33	15.63	12.47	65.33
10	20	19.9	0.49	0.49	32.42	13.63	10.48	55.42
10	35	34.9	0.82	0.83	32.83	11.72	8.57	46.83



Measured Rotation of Slope Inclinometer Casing
Test Site 1



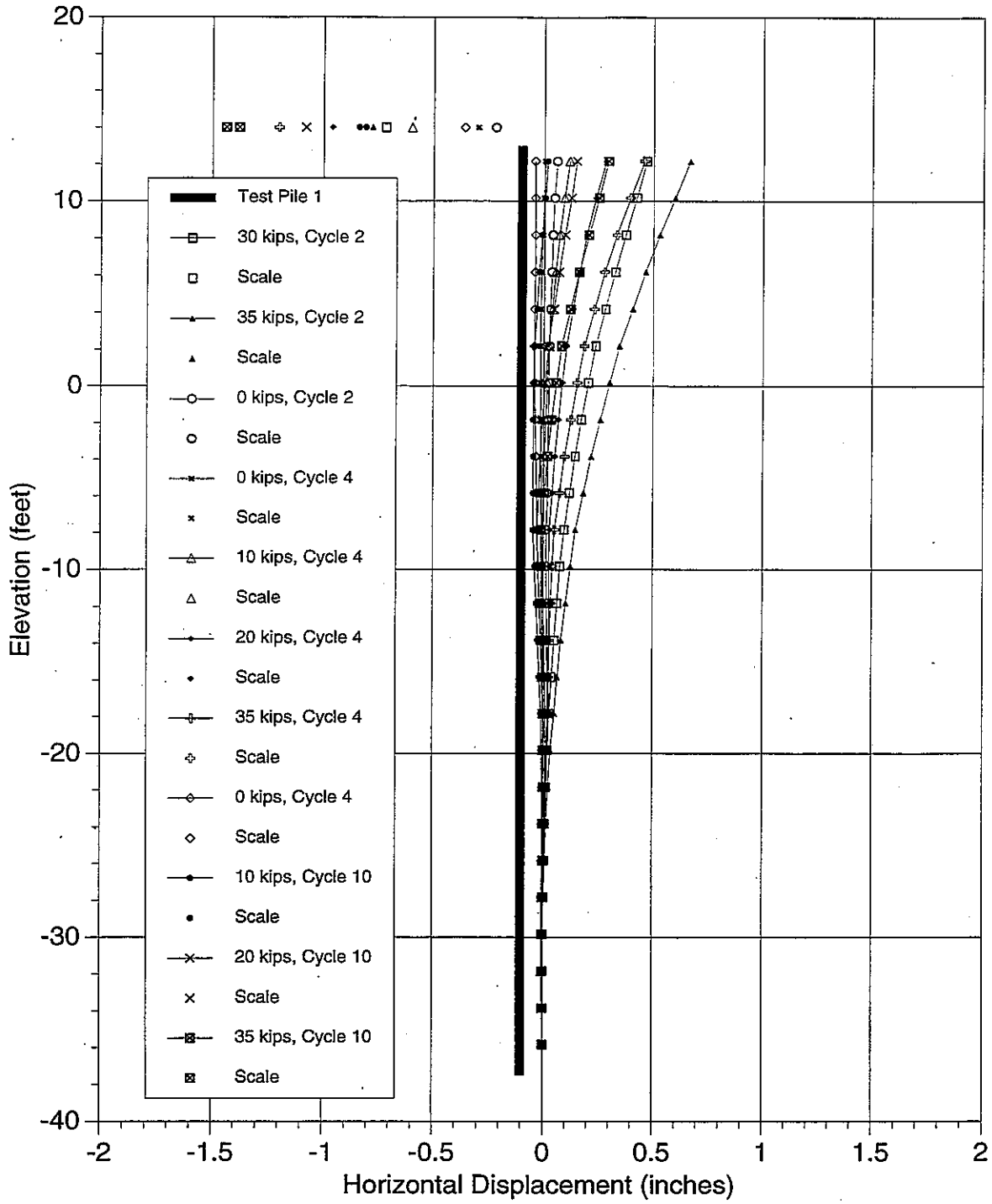
Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 11/16/94
Date Tested: 12/1/94
Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -37.5 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -8.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 1 (Test 1)



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/16/94

Date Tested: 12/2/94

Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

Pile Tip Elevation: -37.5 feet

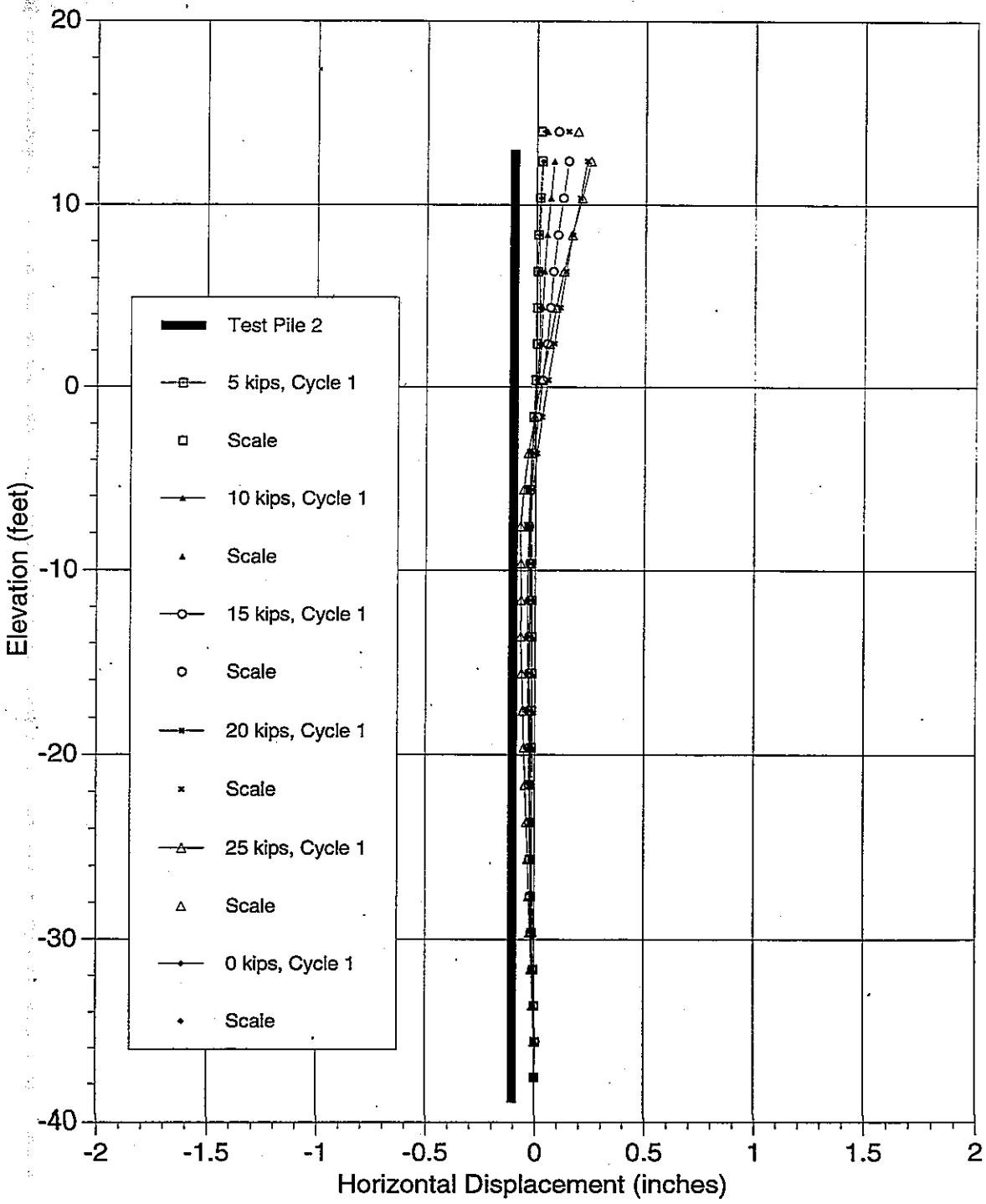
Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -8.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 1 (Test 2)



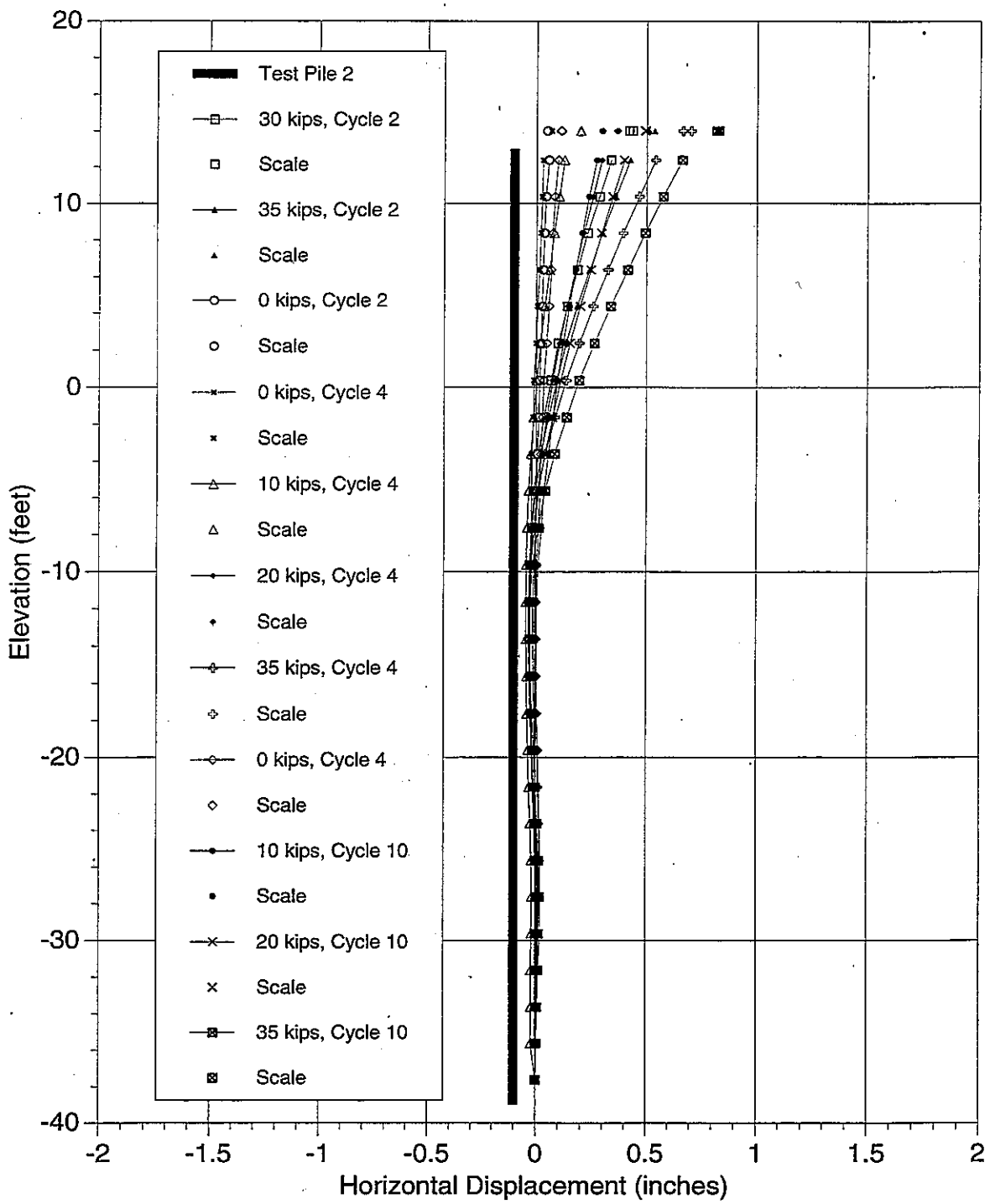
Pile Type: Fundex PP 20x0.5
Grout Volume: 720 gallons
Date Installed: 11/17/94
Date Tested: 12/1/94
Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -39.0 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -1.3 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 2 (Test 1)



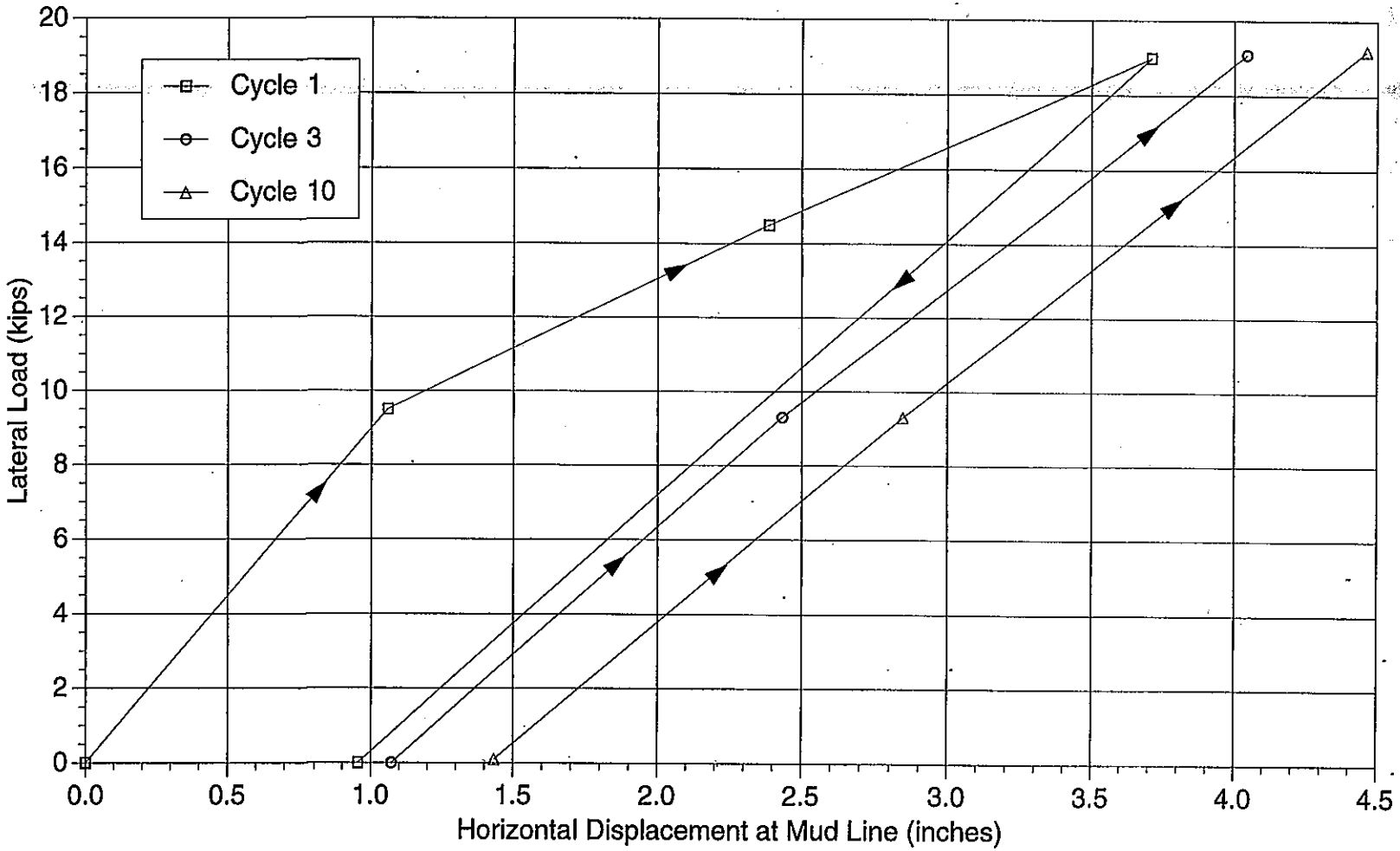
Pile Type: Fundex PP 20x0.5
Grout Volume: 720 gallons
Date Installed: 11/17/94
Date Tested: 12/2/94
Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -39.0 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -1.3 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 2 (Test 2)



Pile Type: Fundex PP 20x0.5 (-45.5' to -8.5') PP 20x0.75 (-8.5' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 3 hours 55 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

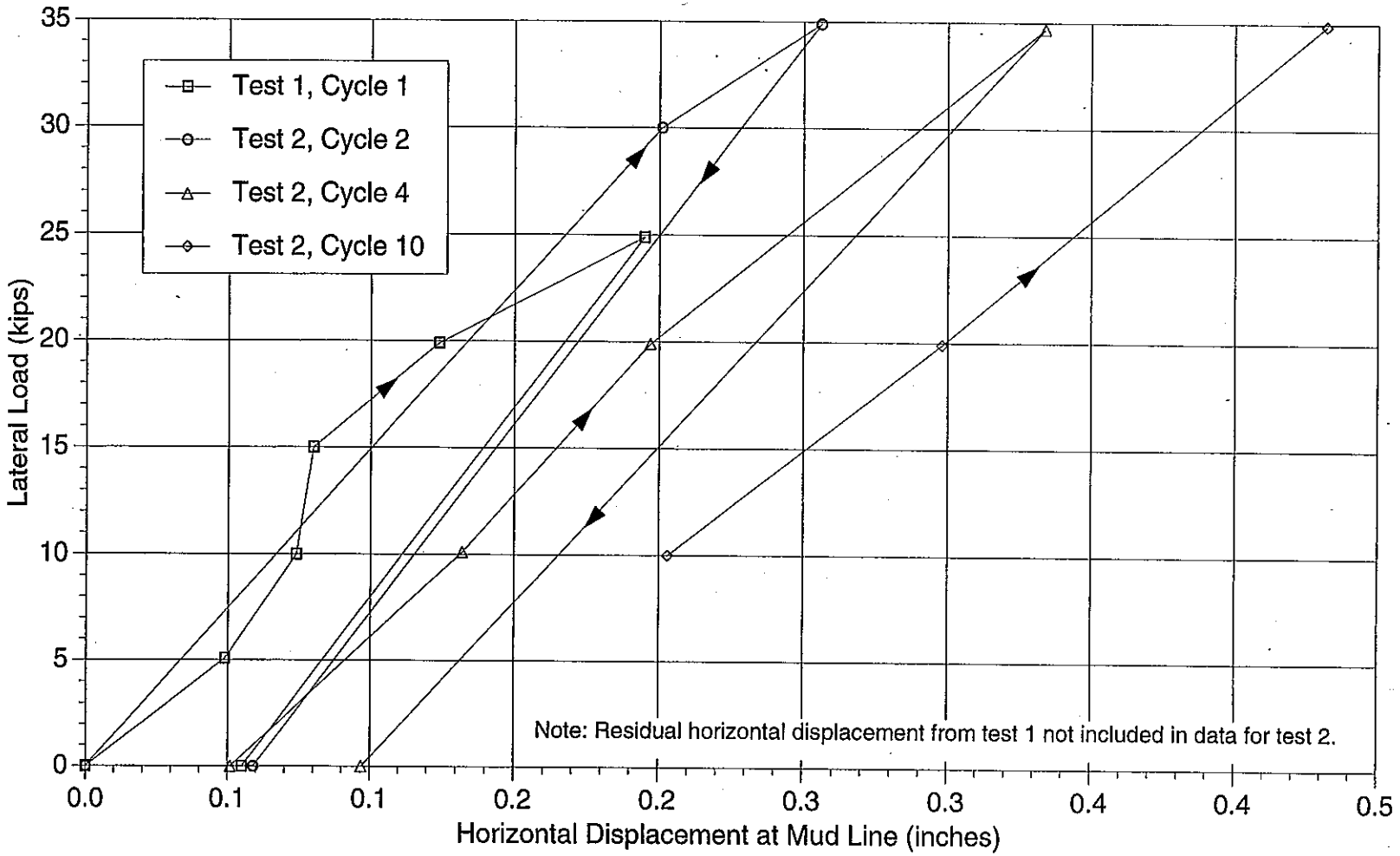
Pile Tip Elevation: -45.5 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Lateral Load - Displacement at Mud Line

Test Site 2, Pile 4



Pile Type: Fundex PP 20x0.5

Grout Volume: 720 gallons

Date Installed: 11/17/94

Date Tested: Test 1: 12/1/94, Test 2: 12/2/94

Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

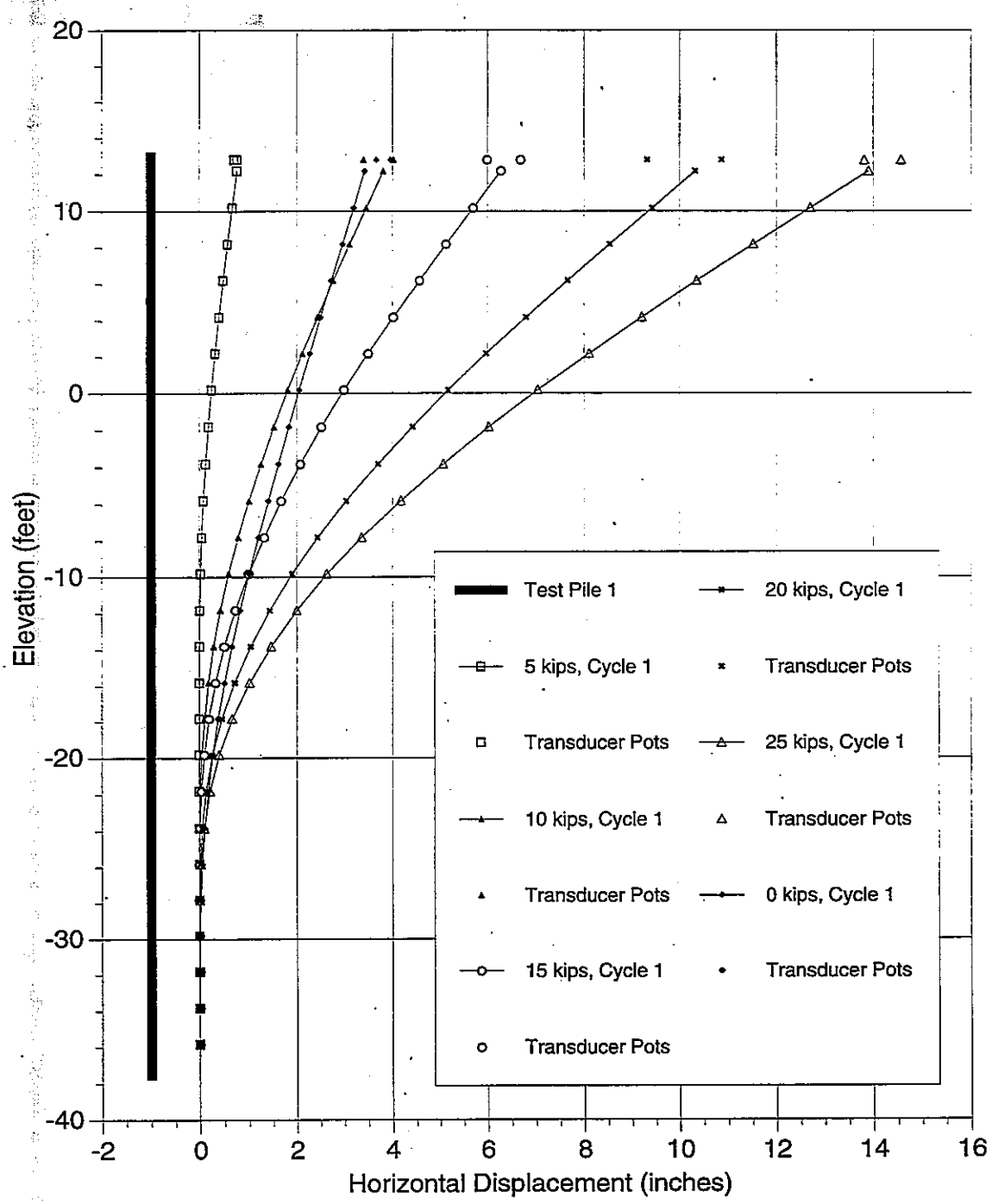
Pile Tip Elevation: -39.0 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -1.3 feet

Lateral Load - Displacement at Mud Line

Test Site 1, Pile 2

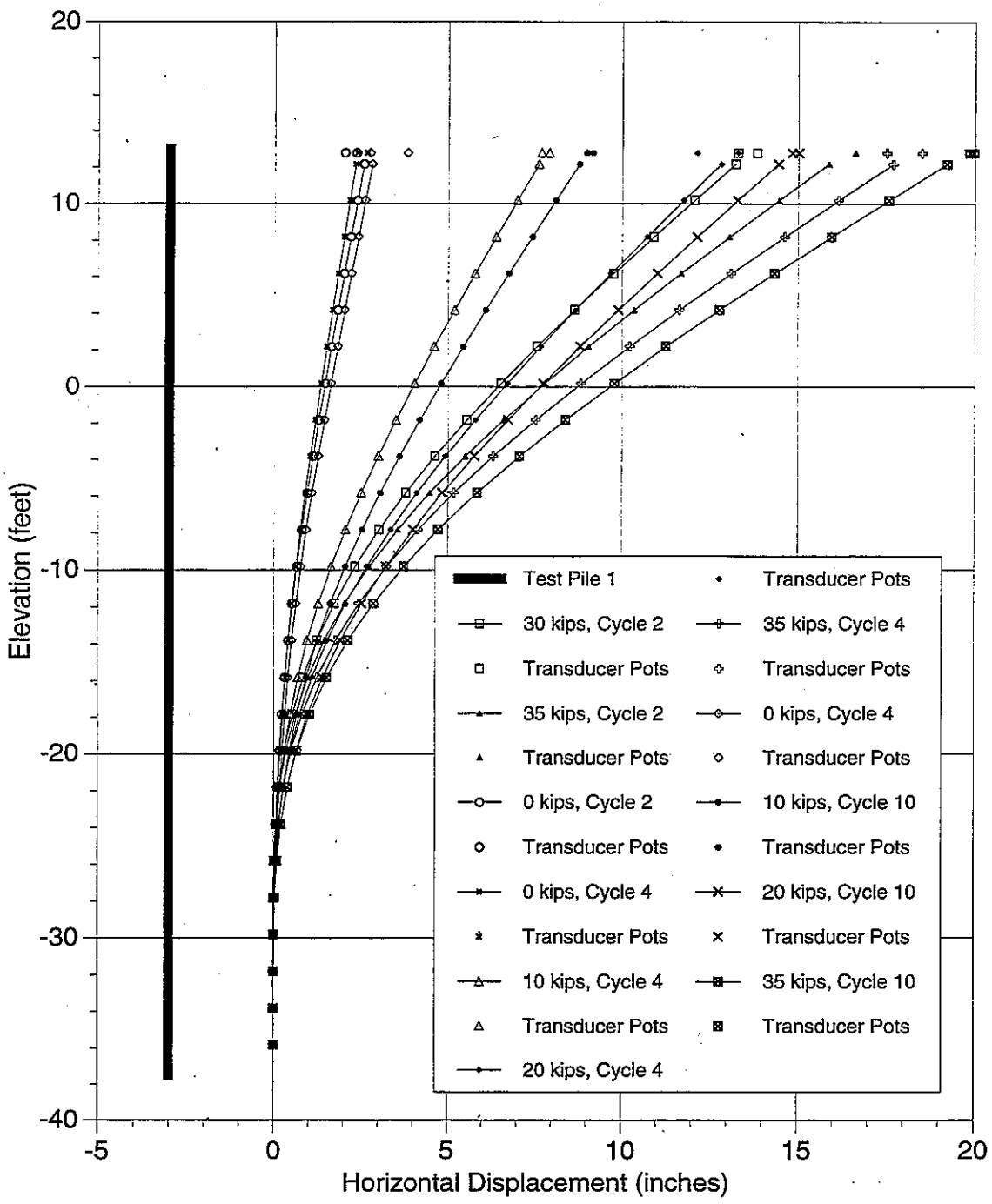


Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 11/16/94
Date Tested: 12/1/94
Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -37.5 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -8.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load
Test Site 1, Pile 1 (Test 1)

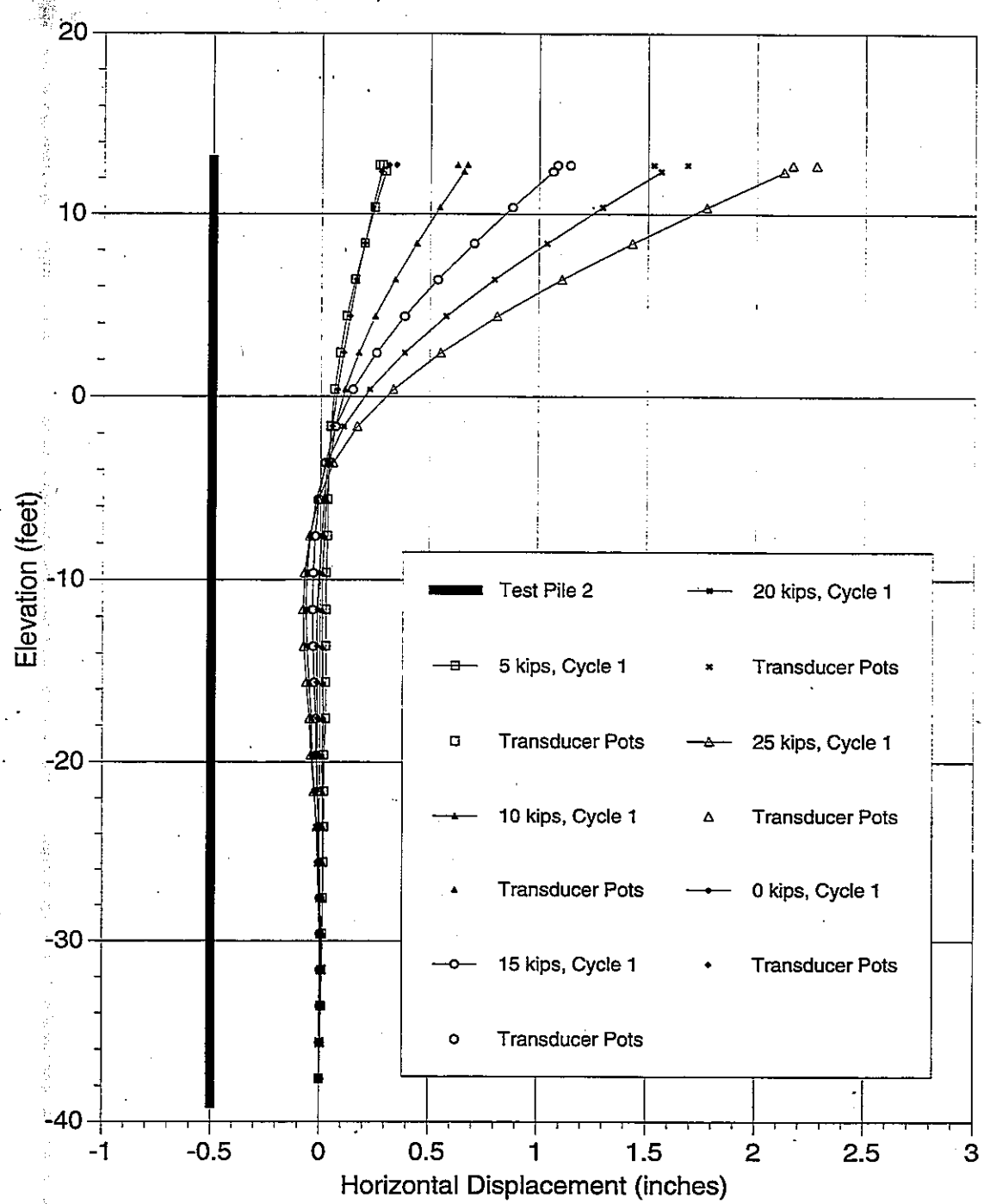


Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 11/16/94
Date Tested: 12/2/94
Installation Time: 5 hours 38 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -37.5 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -8.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load
Test Site 1, Pile 1 (Test 2)

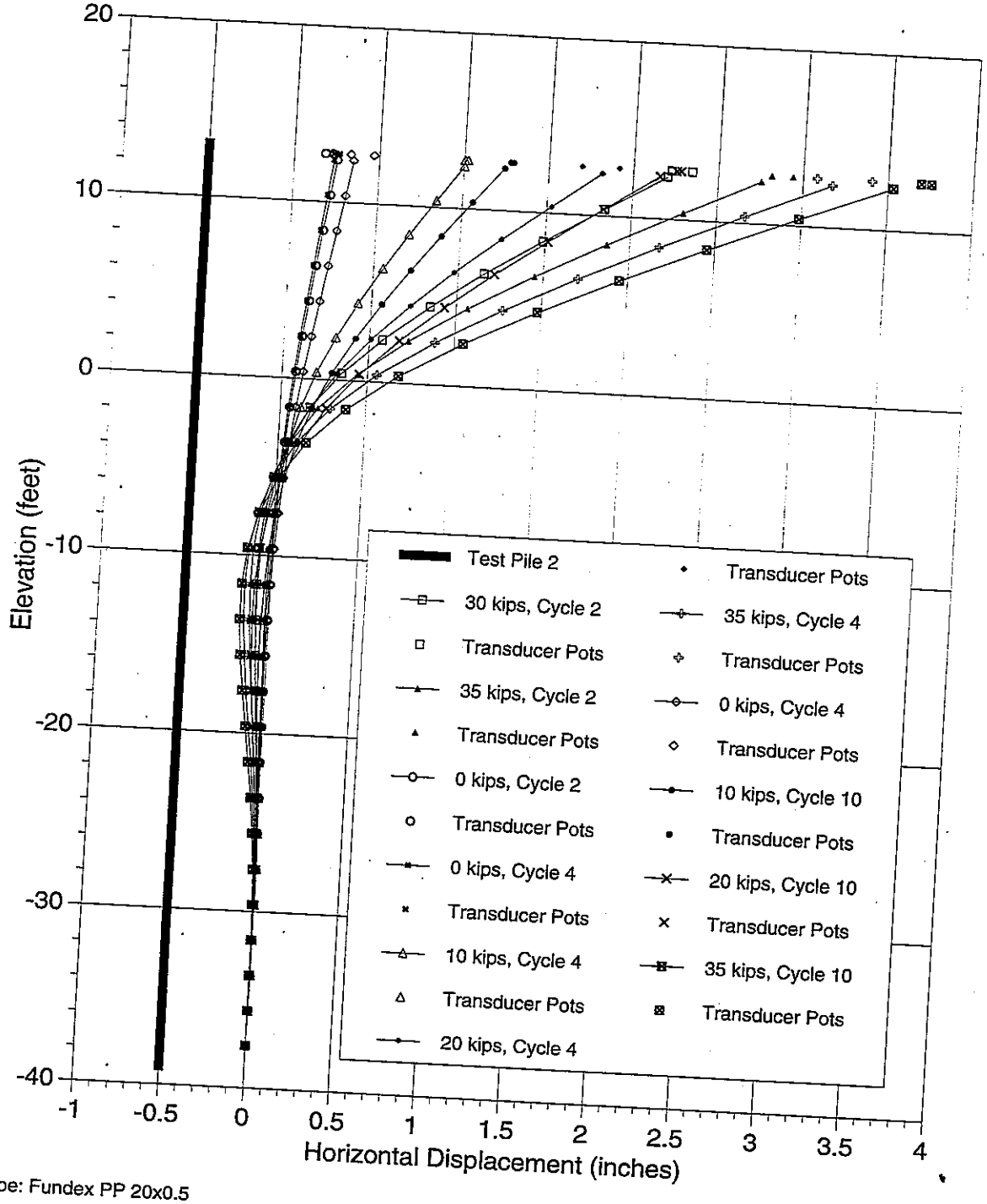


Pile Type: Fundex PP 20x0.5
Grout Volume: 720 gallons
Date Installed: 11/17/94
Date Tested: 12/1/94
Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -39.0 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -1.3 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load
Test Site 1, Pile 2 (Test 1)

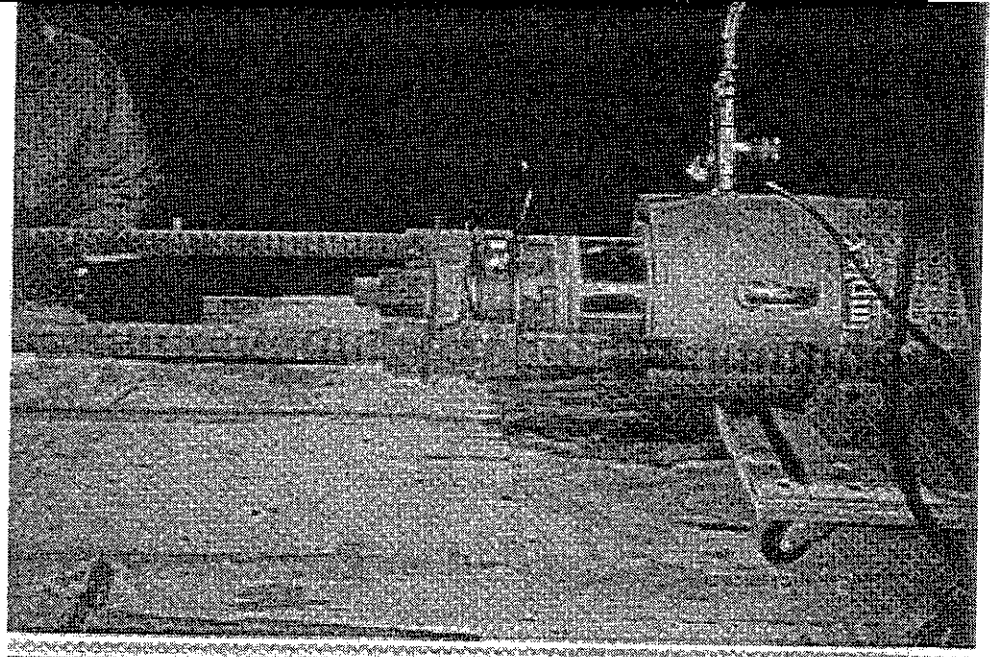


Pile Type: Fundex PP 20x0.5
Grout Volume: 720 gallons
Date Installed: 11/17/94
Date Tested: 12/2/94
Installation Time: 5 hours 36 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -39.0 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -1.3 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load
Test Site 1, Pile 2 (Test 2)



INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

Appendix F

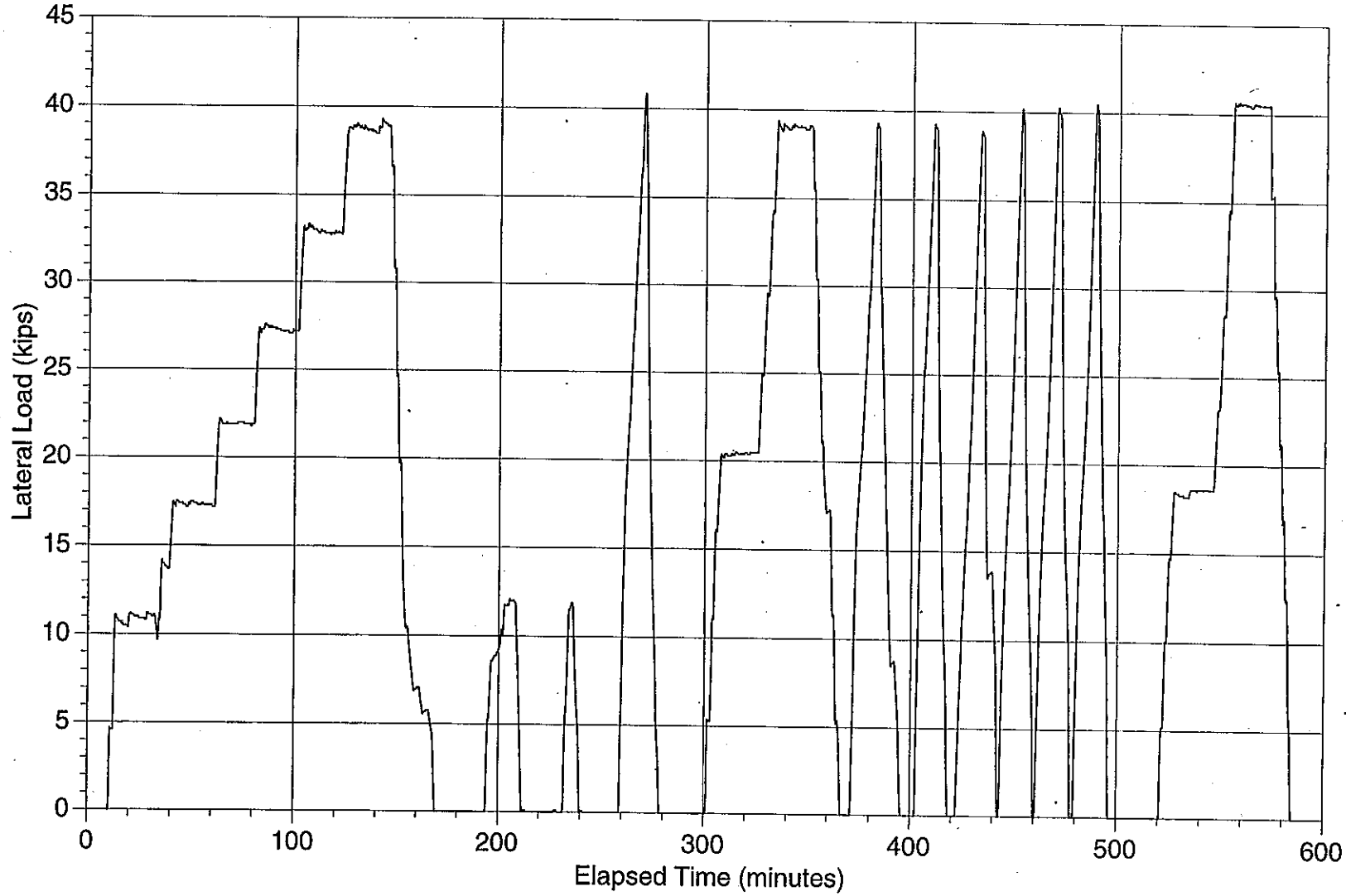
Site 1
Piles 3 and 4
Lateral Load Test Plots

Top: Load Cell at the end of the jacks during a lateral load test at night.

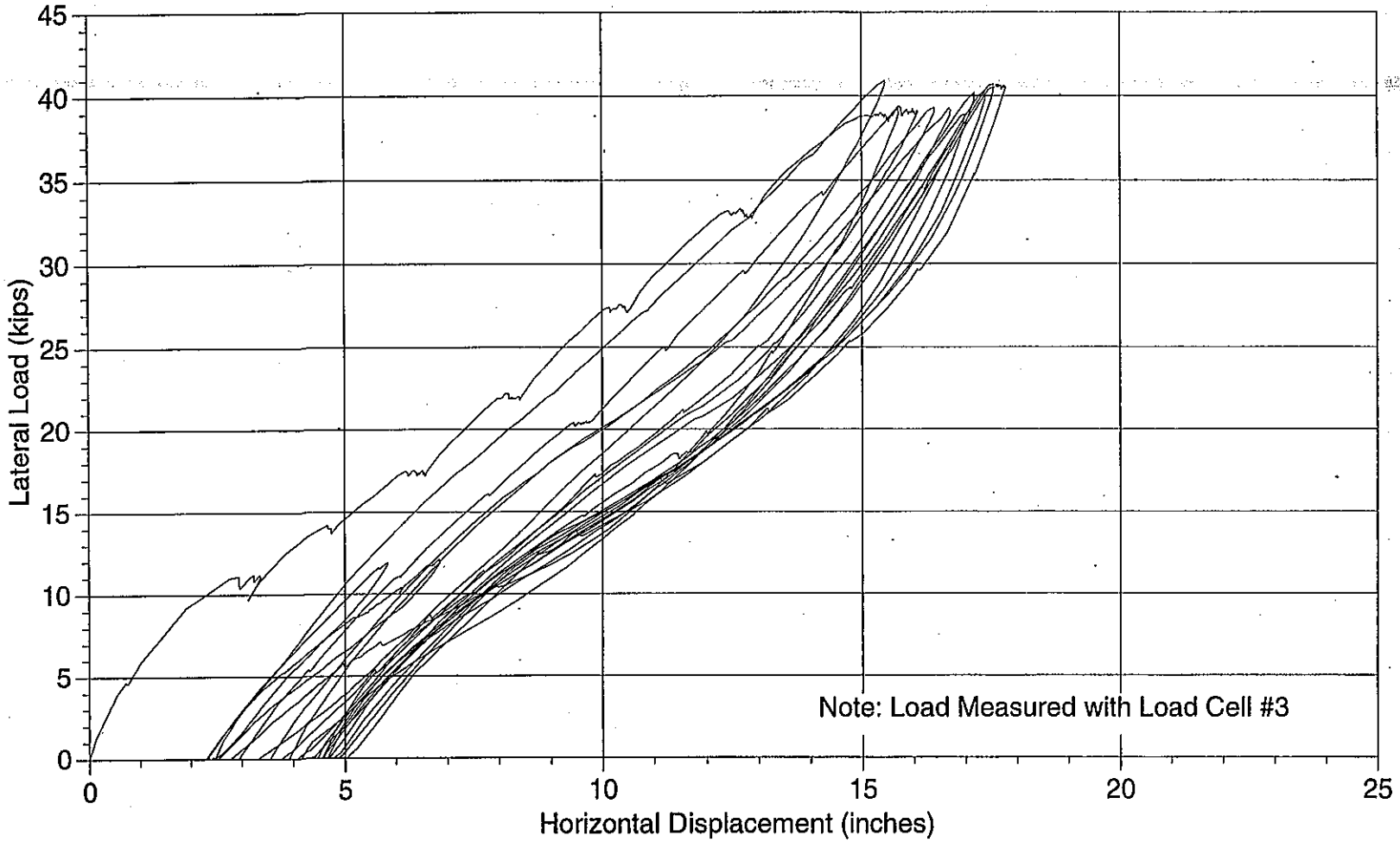
Middle: Plumbing pile at the beginning of pile installation at Site 1

Bottom: Performing lateral load test in the rain at Site 2

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995



Lateral Load - Time History
Test Site 1, Pile 3 and Pile 4



Pile Type: Fundex PP 20x0.5 (-35.2' to -7.2') PP 20x0.75 (-7.2' to 13.0')

Grout Volume: 320 gallons

Date Installed: 11/21/94

Date Tested: 12/6/94

Installation Time: 5 hours 19 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

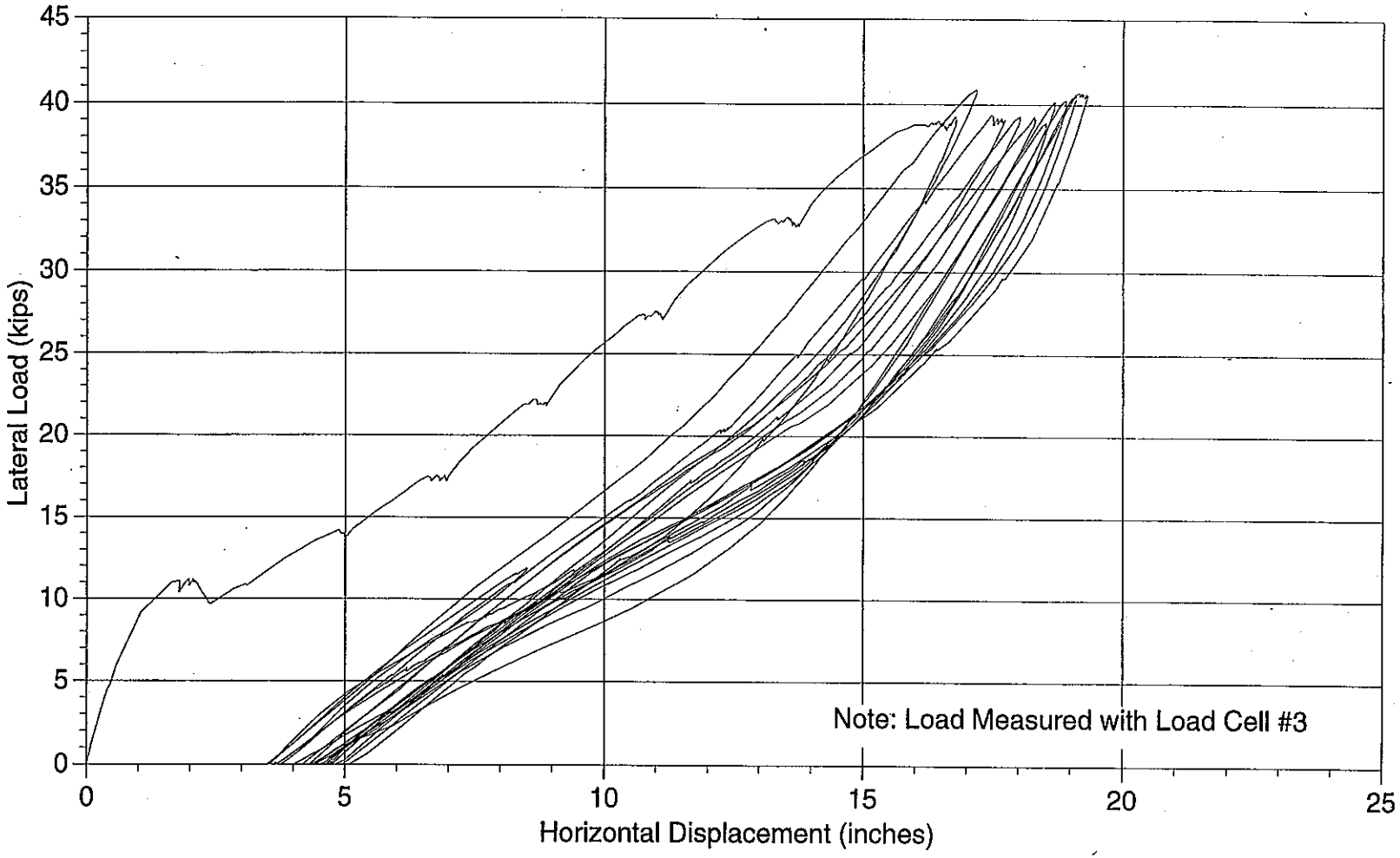
Pile Tip Elevation: -35.2 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -5.5 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 3



Pile Type: Fundex PP 20x0.5 (-36.5' to -8.5') PP 20x0.75 (-8.5' to 13.0')

Grout Volume: 240 gallons

Date Installed: 11/21/94

Date Tested: 12/6/94

Installation Time: 4 hours 27 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

Pile Tip Elevation: -36.5 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -6.5 feet

Lateral Load - Displacement Near Pile Top

Test Site 1, Pile 4

Summary of Slope Inclinometer Reading Events
Test Site 1, Pile 4

Test Date 12/6/94

Slope Inclinometer Serial Number: 25690

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			2.58	1.15		
1	0	0.0			0.92	1.41		
1	10	10.8	1.36	3.10	-3.04	5.93	4.51	8.96
1	20	17.3	6.62	6.95	-3.46	2.89	1.47	5.46
1	25	21.9	8.53	8.89	-4.54	2.68	1.26	6.46
1	30	27.3	10.76	11.15	-4.42	3.00	1.59	5.58
1	35	32.9	13.28	13.75	-4.33	2.36	0.95	5.67
1	40	38.8	15.85	16.78	-10.38	5.47	4.06	11.63
1	0	0.0	3.75	3.55	-1.33	1.49	0.08	3.67
3	0	0.0	3.90	3.75	-1.58	1.75	0.34	4.42
3	20	20.4	12.20	12.42	-5.71	1.93	0.51	4.29
3	40	39.0	17.47	17.72	-6.83	2.03	0.62	3.83
10	0	0.0	4.94	4.70	-1.63	2.46	1.05	5.38
10	20	18.5	13.81	14.01	-6.96	4.16	2.75	7.04
10	40	40.5	19.09	19.32	-5.08	1.85	0.43	4.08

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			35.67	5.33		
1	0	0.0			36.00	5.31		
1	10	10.8	0.09	0.11	32.71	7.16	5.75	12.71
1	20	17.3	-0.49	-0.52	34.67	6.63	5.22	12.67
1	25	21.9	-0.67	-0.69	33.54	5.43	4.02	12.54
1	30	27.3	-0.86	-0.89	34.92	5.94	4.53	12.92
1	35	32.9	-1.10	-1.12	35.00	6.10	4.69	13.00
1	40	38.8	-1.31	-1.38	34.08	6.72	5.31	18.08
1	0	0.0	-0.48		36.58	6.03	4.62	14.58
3	0	0.0	-0.50	-0.49	35.04	6.14	4.73	13.04
3	20	20.4	-1.17	-1.18	34.71	6.27	4.86	14.71
3	40	39.0	-1.59	-1.61	34.58	6.16	4.75	17.58
10	0	0.0	-0.65	-0.65	35.79	5.84	4.43	12.79
10	20	18.5	-1.39	-1.39	36.71	6.39	4.97	16.71
10	40	40.5	-1.86	-1.88	36.92	6.80	5.39	17.92

Summary of Slope Inclinometer Reading Events
Test Site 1, Pile 3

Test Date 12/6/94

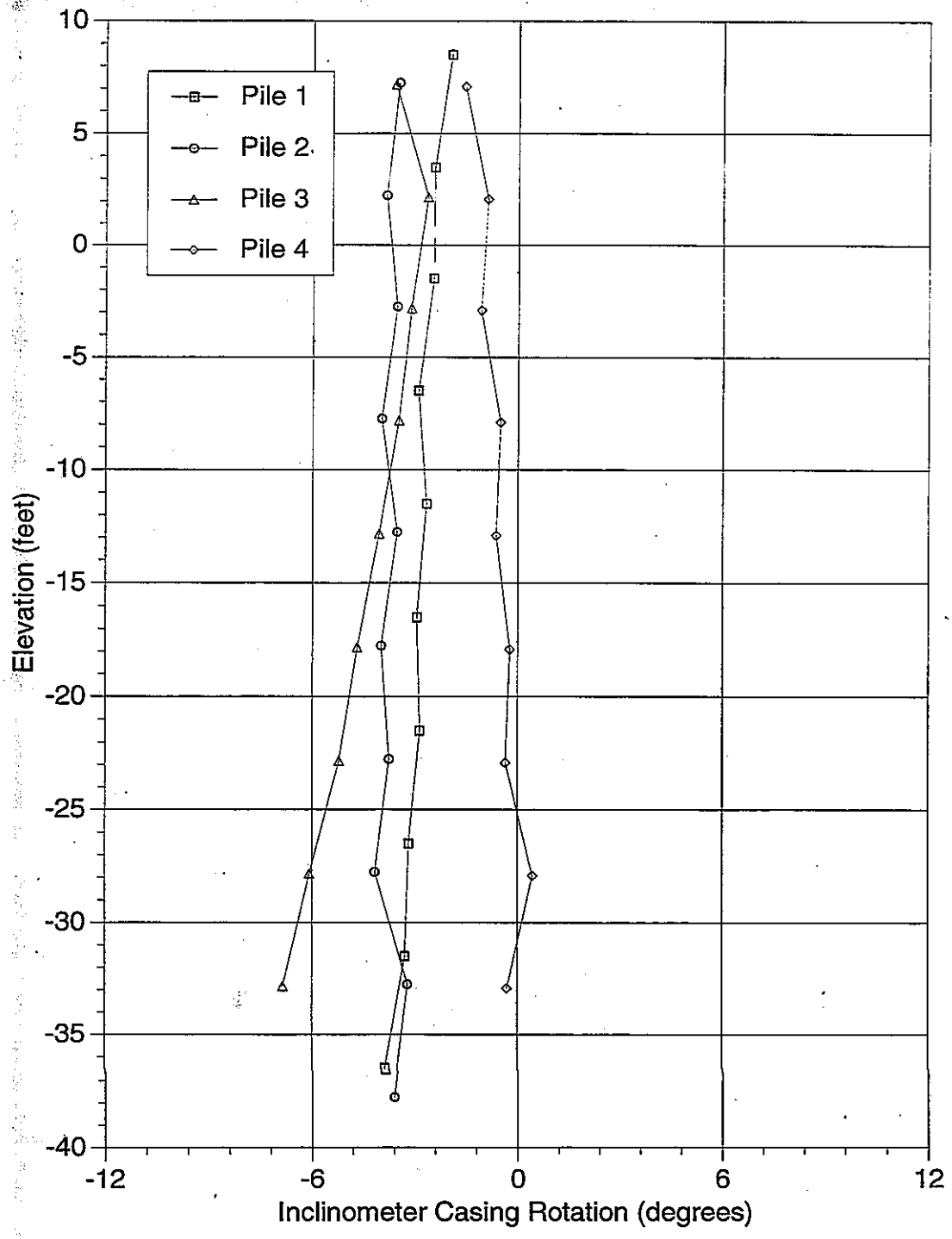
Slope Inclinometer Serial Number: 27444

Measurements in Direction of Applied Lateral Load (A-Direction)

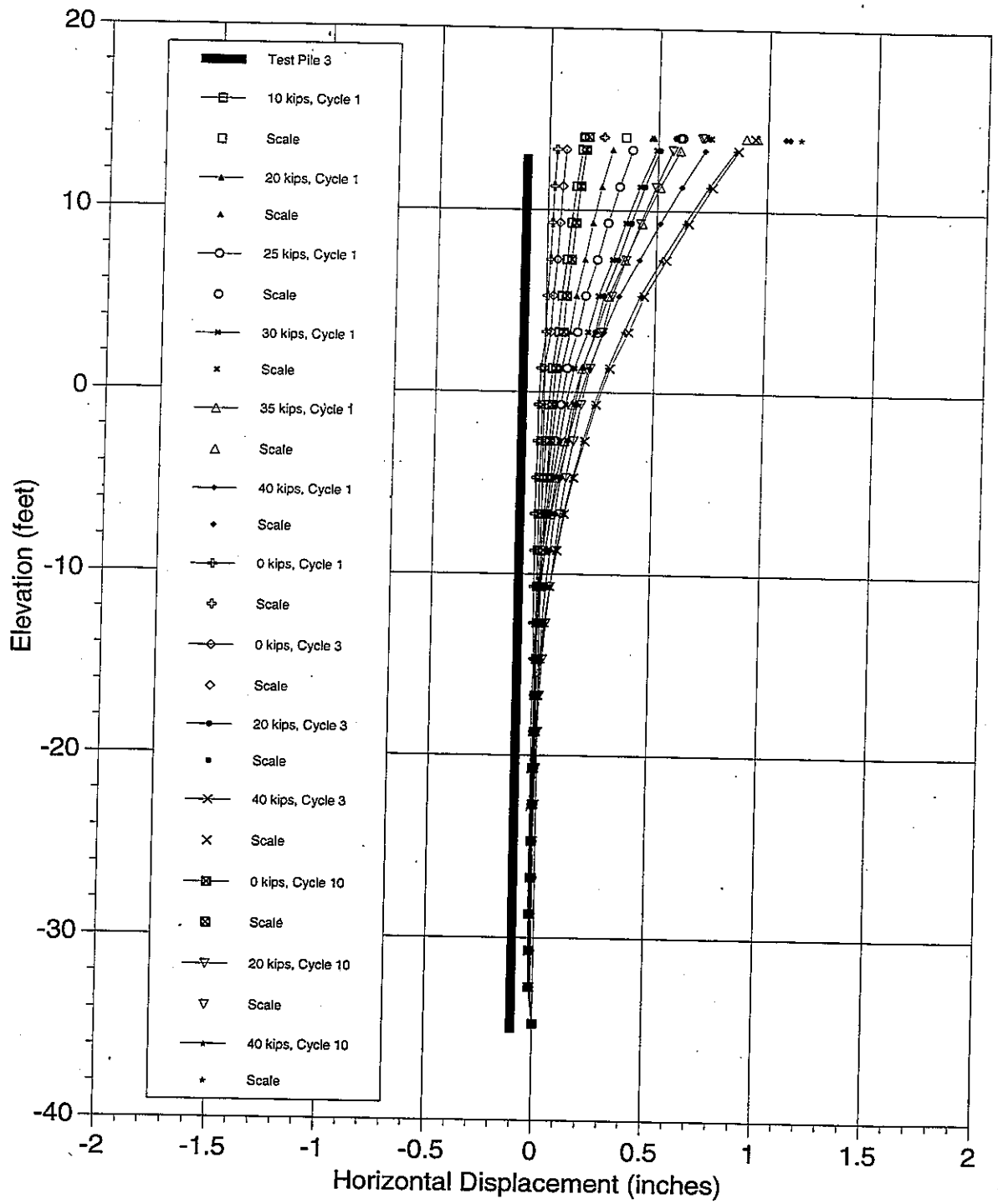
Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-4.83	3.77		
1	0	0.0			-0.38	1.89		
1	10	9.8	2.35	3.37	-13.79	7.22	5.33	14.21
1	20	19.9	6.22	6.58	-9.25	3.28	1.39	7.25
1	25	25.0	8.05	8.42	-8.96	3.18	1.29	8.96
1	30	30.0	10.14	10.53	-4.42	2.78	0.89	7.42
1	35	34.9	12.43	12.88	-2.25	3.44	1.55	9.25
1	40	40.0	14.87	15.72	-2.88	4.03	2.15	10.13
1	0	0.0	2.78	2.48	3.92	1.93	0.05	5.08
3	0	0.0	3.22	2.94	2.79	2.22	0.33	4.79
3	20	19.8	9.38	9.79	-3.58	4.19	2.30	7.58
3	40	39.9	15.73	16.09	-1.71	3.58	1.69	7.71
10	0	0.0	4.87	4.56	1.63	1.65	0.24	4.63
10	20	19.6	11.36	11.72	-4.29	6.41	4.52	10.71
10	40	39.9	17.46	17.80	0.04	2.73	0.84	7.04

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-21.88	5.95		
1	0	0.0			-17.96	9.76		
1	10	9.8	0.16	0.35	-24.58	5.45	3.56	13.58
1	20	19.9	0.47	0.48	-22.13	5.62	3.73	15.13
1	25	25.0	0.60	0.61	-23.00	7.80	5.92	27.00
1	30	30.0	0.73	0.74	-23.71	7.54	5.65	28.29
1	35	34.9	0.90	0.95	-22.38	7.02	5.13	23.63
1	40	40.0	1.08	1.10	-22.46	7.33	5.44	21.54
1	0	0.0	0.25		-20.71	4.63	2.74	12.29
3	0	0.0	0.25	0.16	-24.08	6.12	4.23	20.92
3	20	19.8	0.58	0.58	-22.83	8.73	6.84	30.17
3	40	39.9	0.94	0.94	-21.83	8.91	7.02	32.17
10	0	0.0	0.18		-23.88	6.29	4.40	18.13
10	20	19.6	0.70	0.71	-22.00	7.02	5.13	20.00
10	40	39.9	1.10	1.15	-22.67	7.22	5.33	18.33



Measured Rotation of Slope Inclinometer Casing
Test Site 1



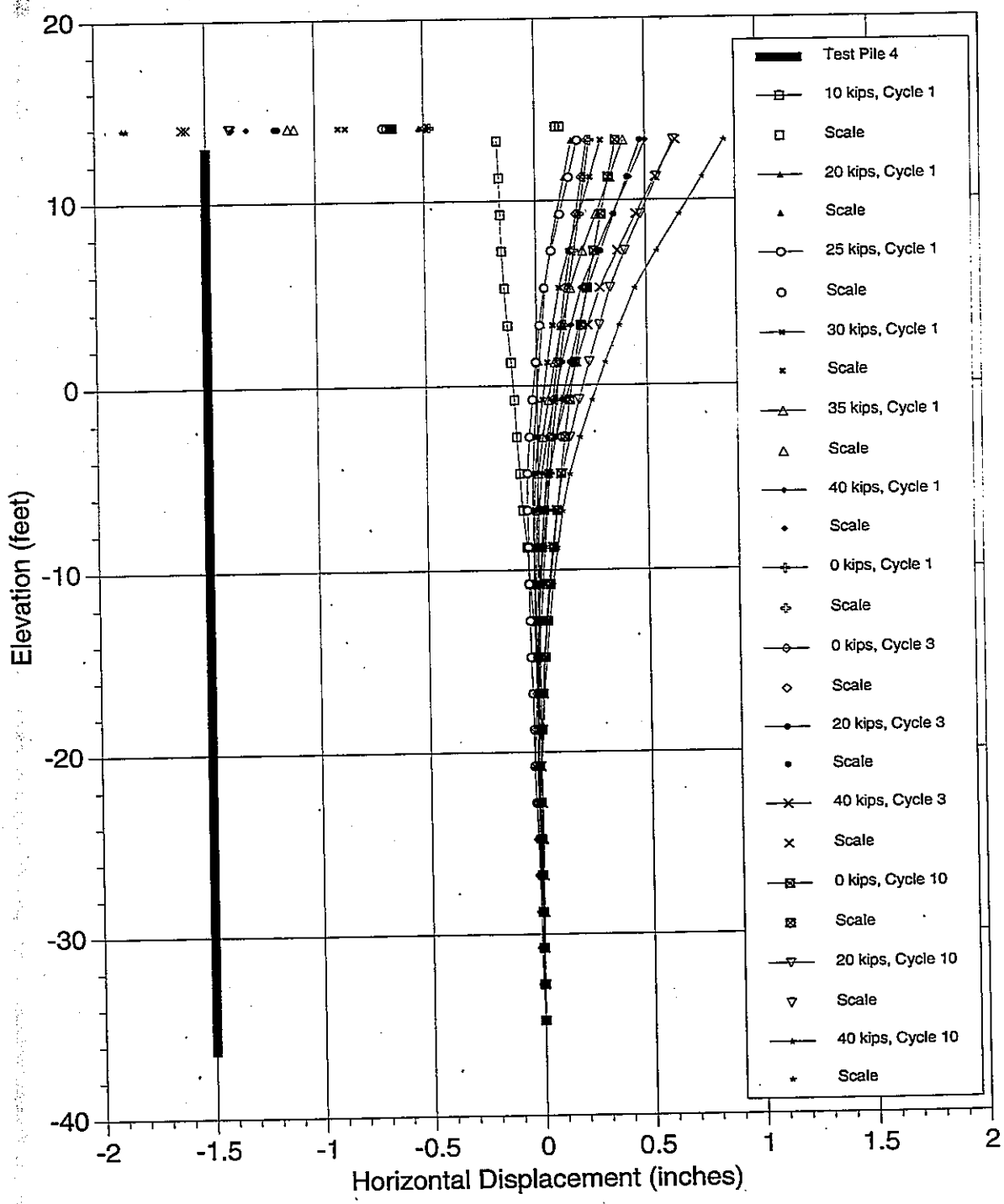
Pile Type: Fundex PP 20x0.5 (-35.2' to -7.2') PP 20x0.75 (-7.2' to 13.0')
Grout Volume: 320 gallons
Date Installed: 11/21/94
Date Tested: 12/6/94
Installation Time: 5 hours 19 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -35.2 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -5.5 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 3



Pile Type: Fundex PP 20x0.5 (-36.5' to -8.5') PP 20x0.75 (-8.5' to 13.0')

Grout Volume: 240 gallons

Date Installed: 11/21/94

Date Tested: 12/6/94

Installation Time: 4 hours 27 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

Pile Tip Elevation: -36.5 feet

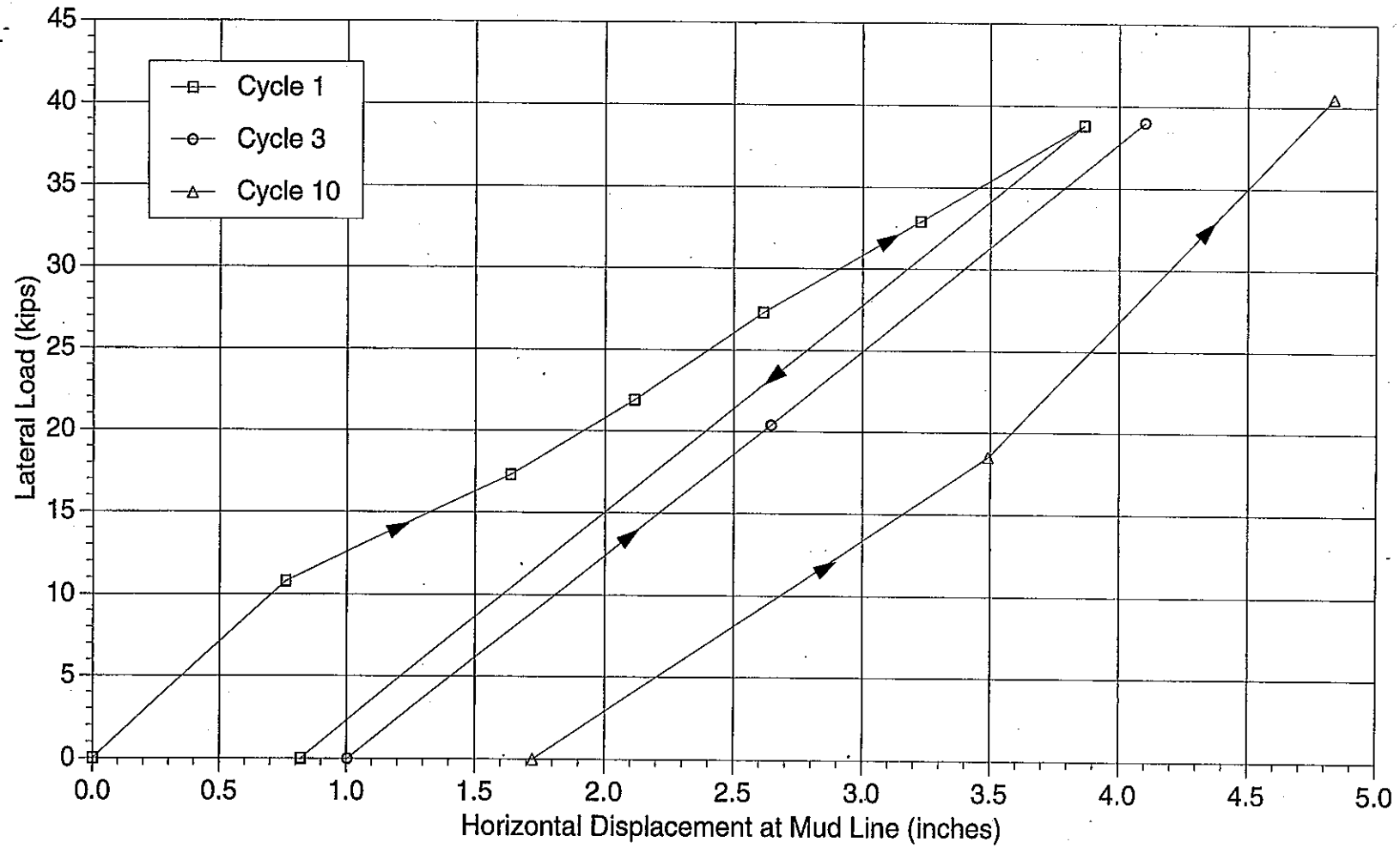
Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -6.5 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 1, Pile 4



Pile Type: Fundex PP 20x0.5 (-35.2' to -7.2') PP 20x0.75 (-7.2' to 13.0')

Grout Volume: 320 gallons

Date Installed: 11/21/94

Date Tested: 12/6/94

Installation Time: 5 hours 19 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

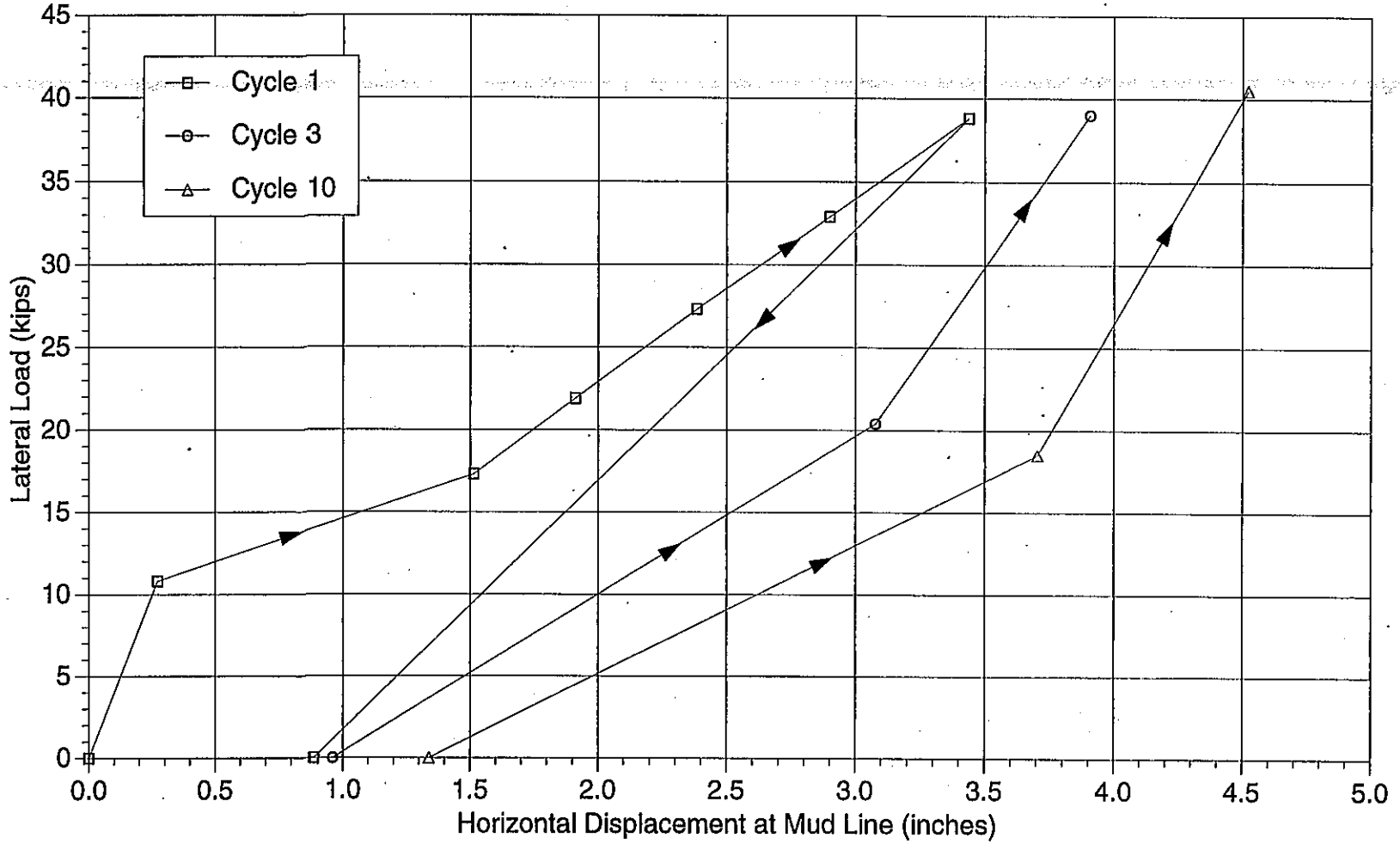
Pile Tip Elevation: -35.2 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -5.5 feet

Lateral Load - Displacement at Mud Line

Test Site 1, Pile 3



Pile Type: Fundex PP 20x0.5 (-36.5' to -8.5') PP 20x0.75 (-8.5' to 13.0')

Grout Volume: 240 gallons

Date Installed: 11/21/94

Date Tested: 12/6/94

Installation Time: 4 hours 27 minutes

Ground Surface Elevation: 10.0 feet

Pile Top Elevation: 13.0 feet

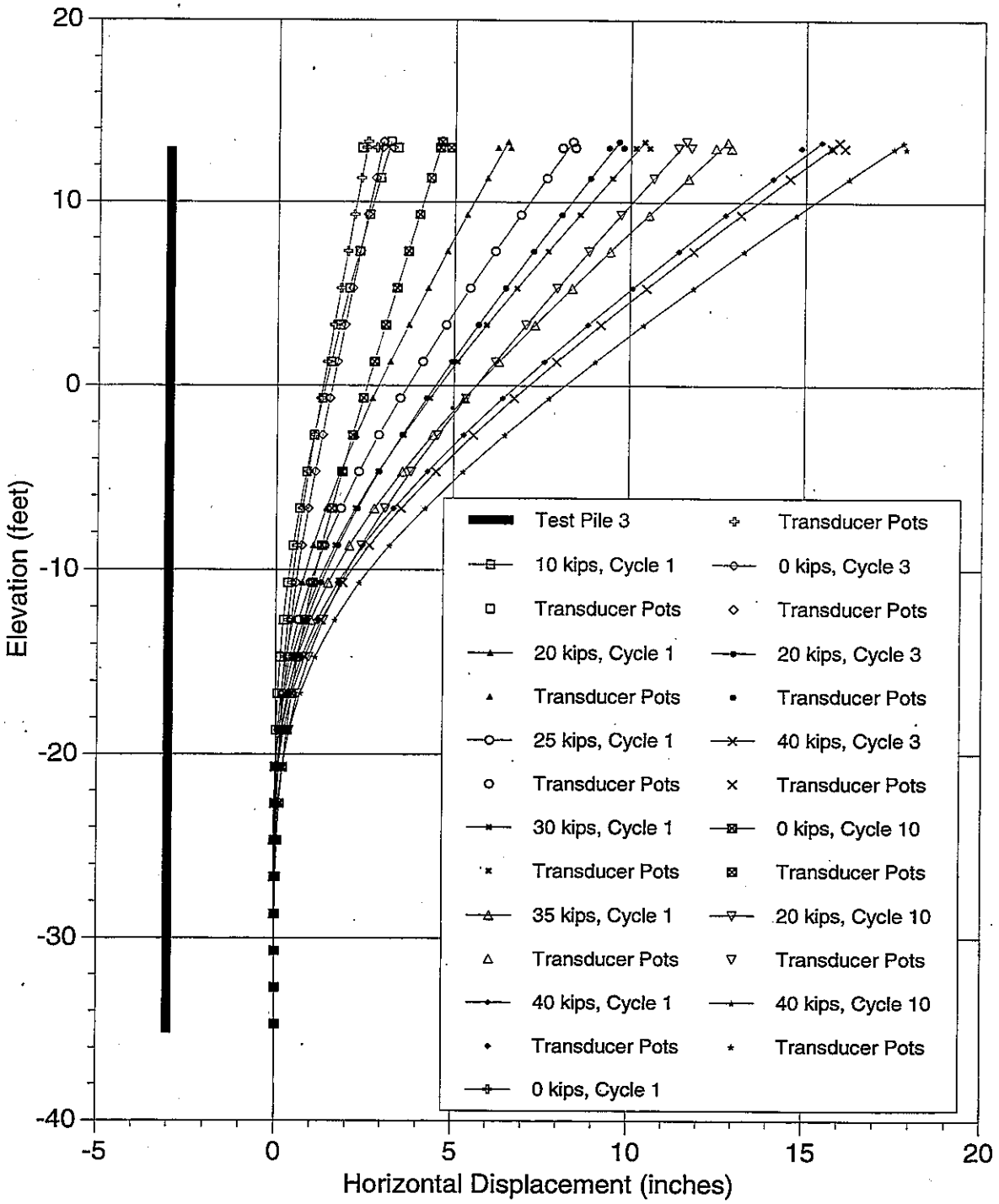
Pile Tip Elevation: -36.5 feet

Bottom of Casing Elevation: -10.0 feet

Top of Mud Line Elevation: -6.5 feet

Lateral Load - Displacement at Mud Line

Test Site 1, Pile 4



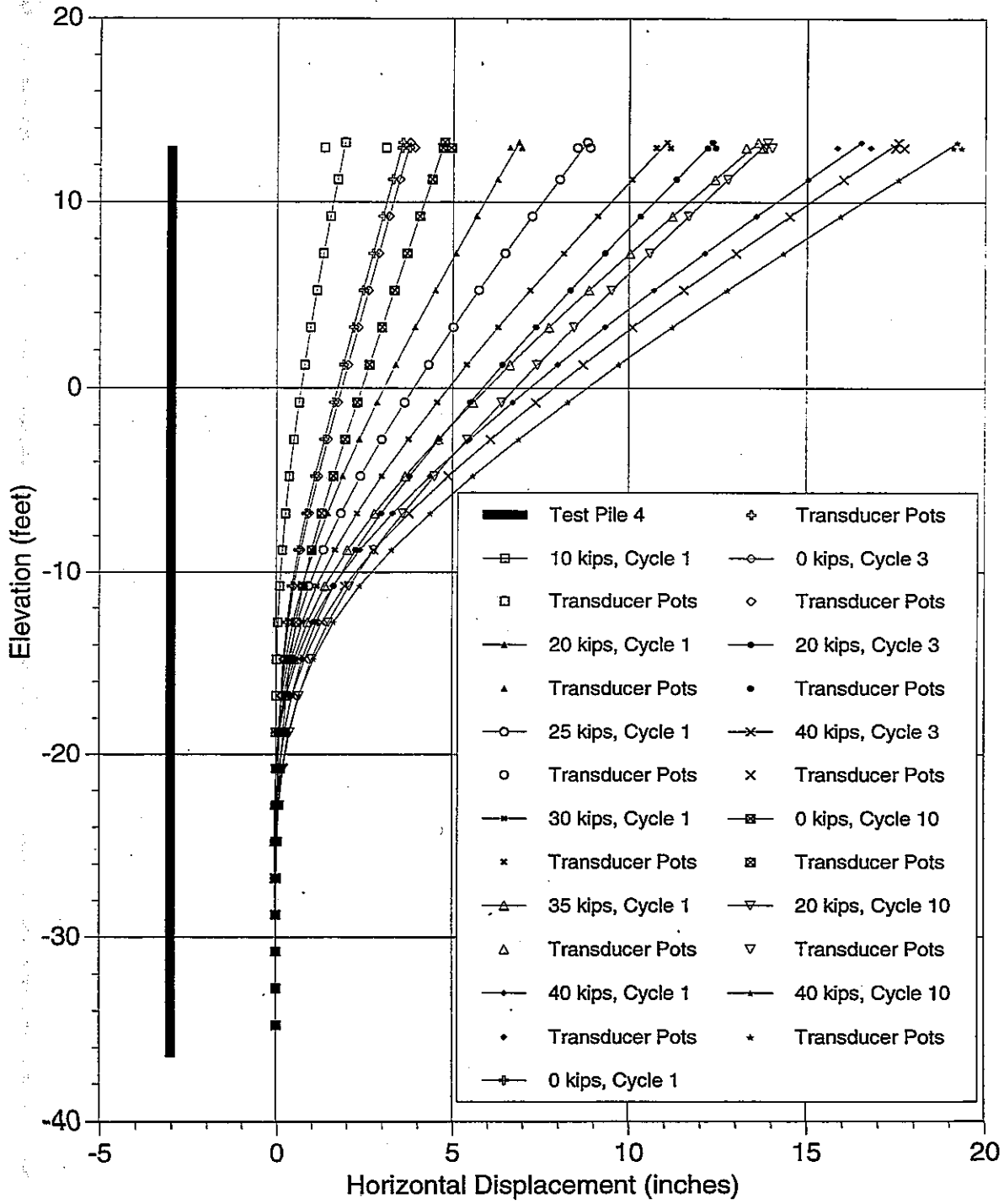
Pile Type: Fundex PP 20x0.5 (-35.2' to -7.2') PP 20x0.75 (-7.2' to 13.0')
Grout Volume: 320 gallons
Date Installed: 11/21/94
Date Tested: 12/6/94
Installation Time: 5 hours 19 minutes

Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -35.2 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -5.5 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 1, Pile 3



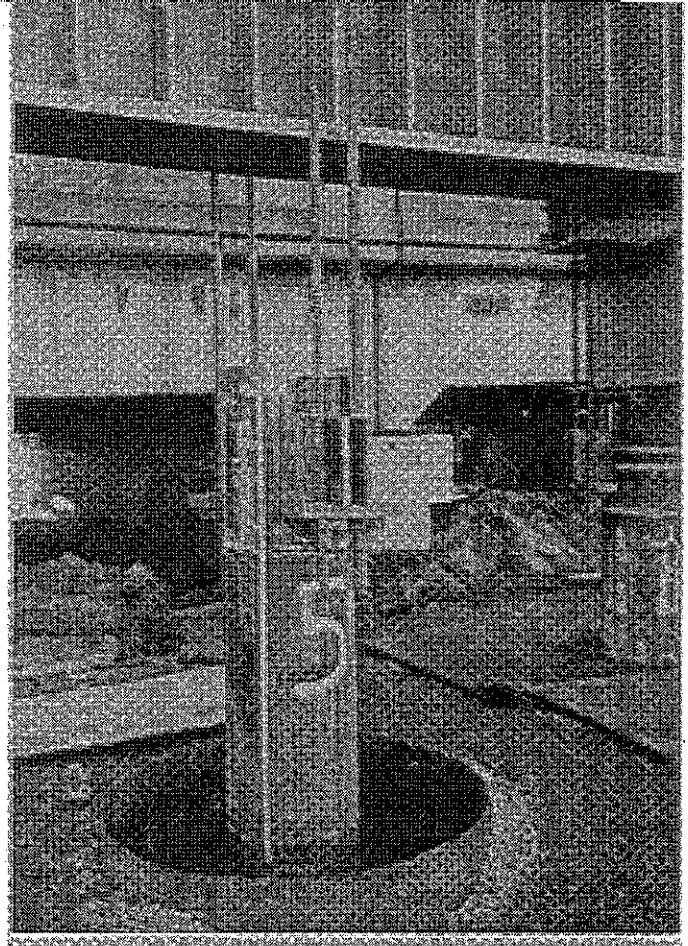
Pile Type: Fundex PP 20x0.5 (-36.5' to -8.5') PP 20x0.75 (-8.5' to 13.0')
Grout Volume: 240 gallons
Date Installed: 11/21/94
Date Tested: 12/6/94
Installation Time: 4 hours 27 minutes

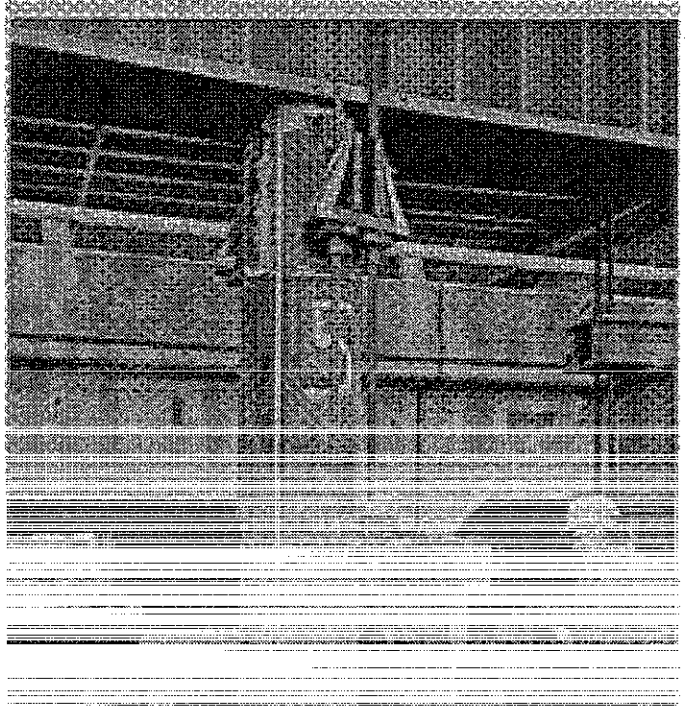
Ground Surface Elevation: 10.0 feet
Pile Top Elevation: 13.0 feet
Pile Tip Elevation: -36.5 feet
Bottom of Casing Elevation: -10.0 feet
Top of Mud Line Elevation: -6.5 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 1, Pile 4





INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

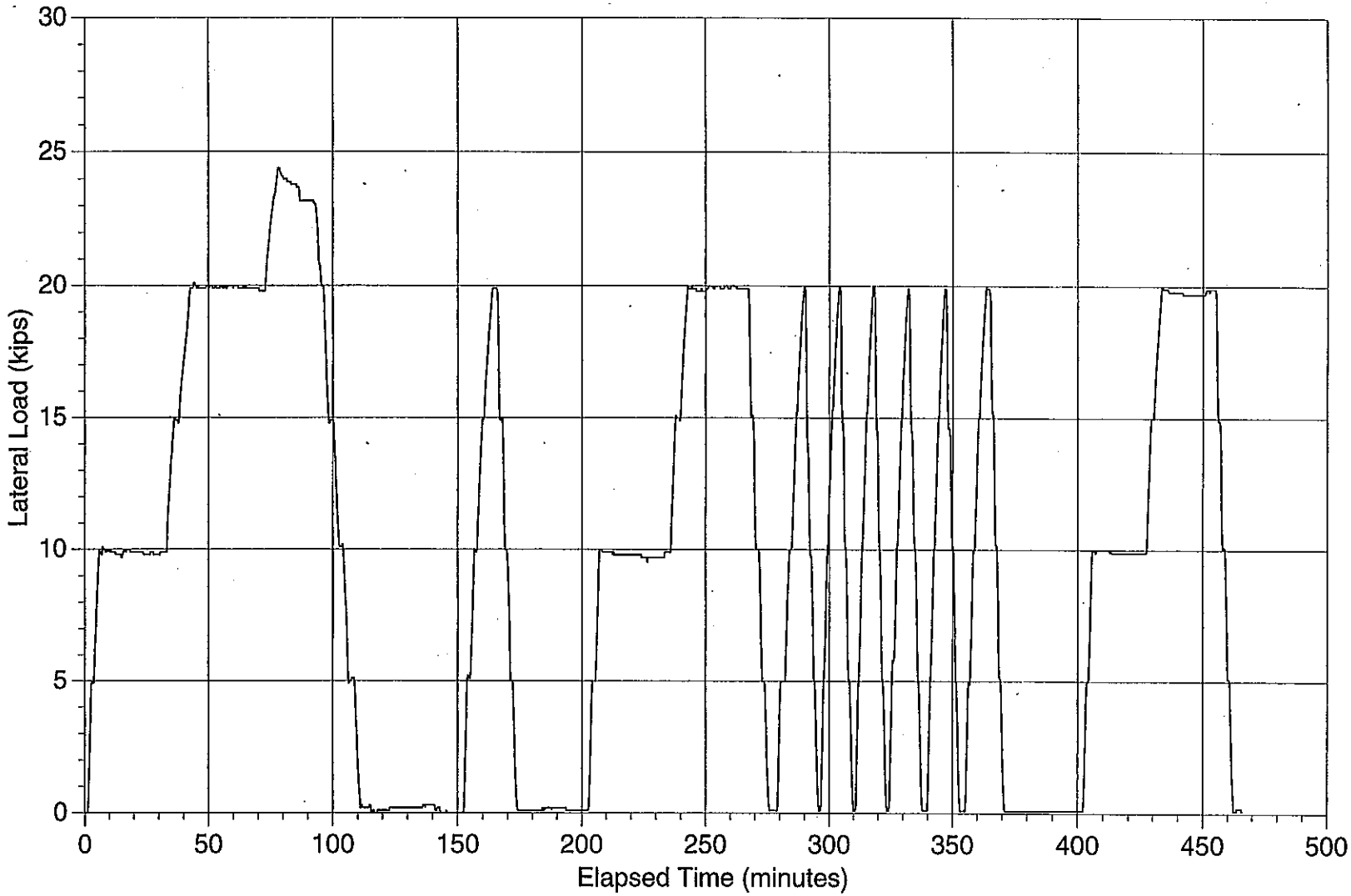
Appendix G

Site 2
Piles 1 and 2
Lateral Load Test Plots

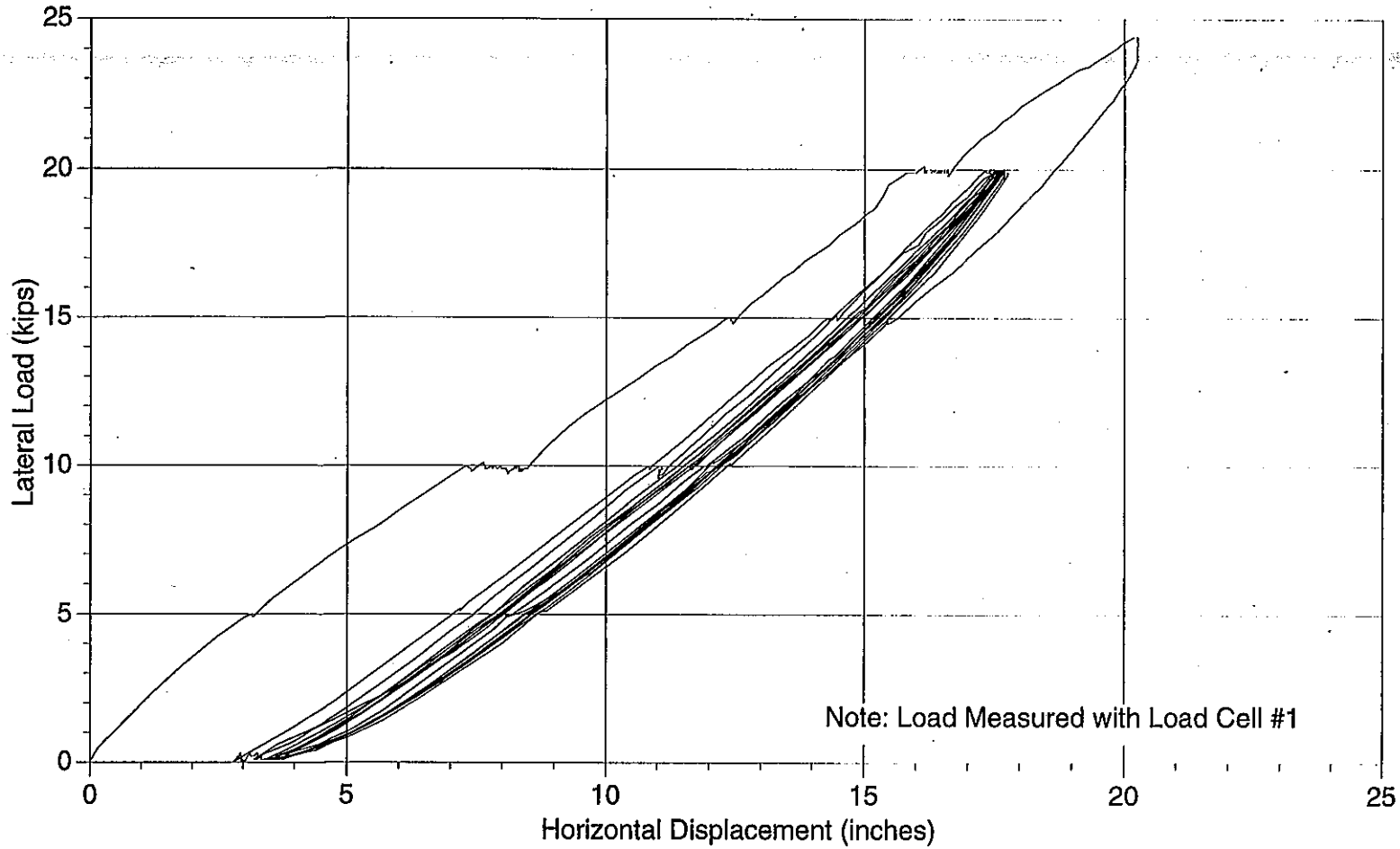
Top: Beginning of pile extraction by hydraulic jacks at Site 1

Bottom: Further along in the pile extraction

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995



Lateral Load - Time History
Test Site 2, Pile 1 and Pile 2



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 12/1/94

Date Tested: 12/14/94

Installation Time: 4 hours 24 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

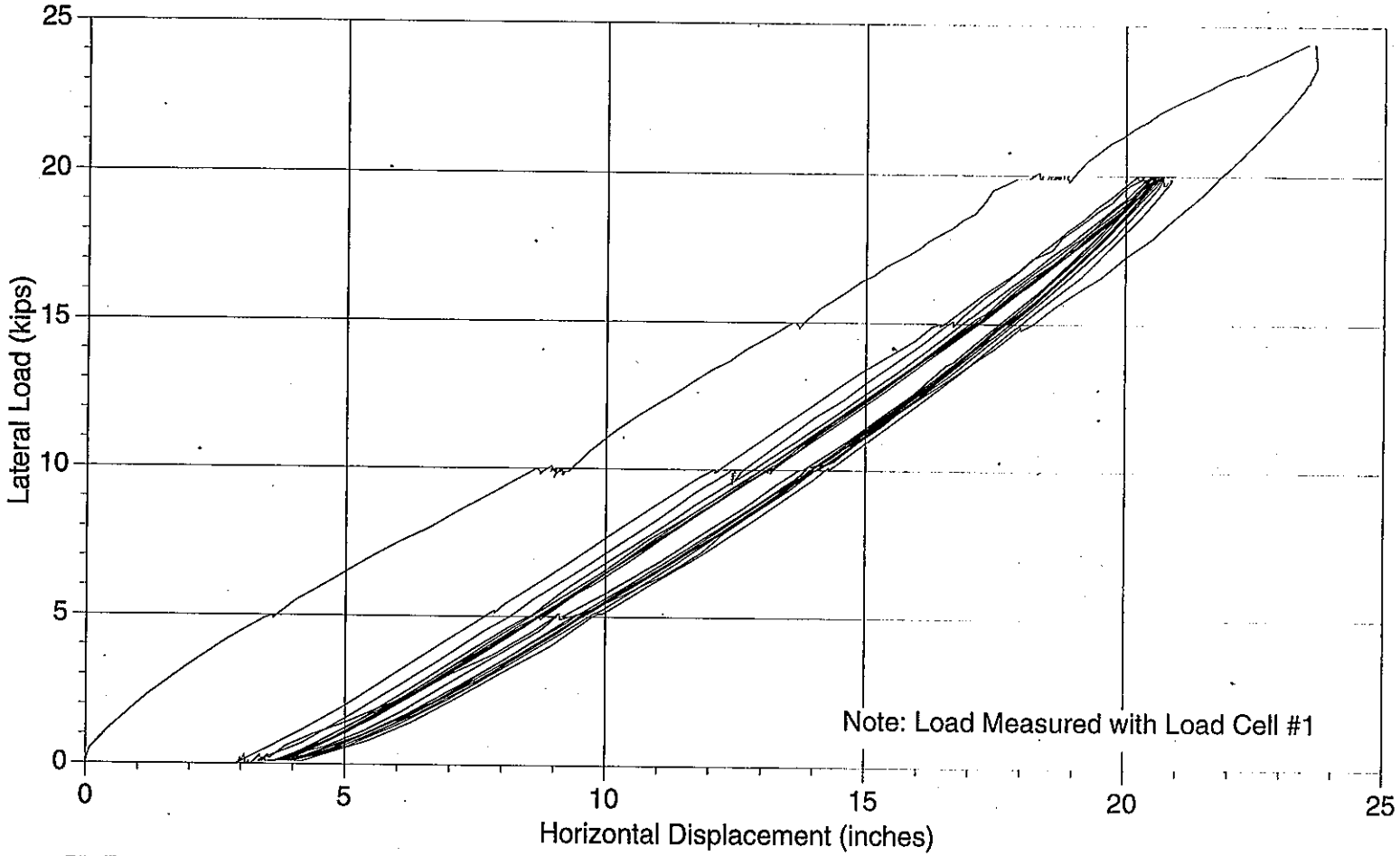
Pile Tip Elevation: -45.0 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Lateral Load - Displacement Near Pile Top

Test Site 2, Pile 1



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/28/94

Date Tested: 12/14/94

Installation Time: 4 hours 52 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -44.9 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -12.1 feet

Lateral Load - Displacement Near Pile Top

Test Site 2, Pile 2

Summary of Slope Inclinometer Reading Events
Test Site 2, Pile 1

Test Date 12/14/94

Slope Inclinometer Serial Number: 27444

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			3.70	2.24		
1	0	0.0			2.40	2.50		
1	10	9.9	7.30	8.47	-2.47	6.08	3.58	16.53
1	20	19.9	15.81	16.73	-2.80	4.71	2.22	9.20
1	0	0.1	3.67	2.80	9.27	2.03	0.47	5.27
3	0	0.1	3.88	3.31	11.60	2.47	0.03	4.60
3	10	9.8	10.95	11.17	8.30	1.59	0.90	4.30
3	20	19.9	17.21	17.57	7.77	2.99	0.49	5.77
10	0	0.1	3.87	3.44	12.77	2.16	0.34	7.77
10	10	9.9	11.60	11.65	12.27	1.98	0.52	6.27
10	20	19.8	17.69	17.75	11.43	2.97	0.48	6.43

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-12.93	6.62		
1	0	0.0			-15.10	6.71		
1	10	9.9	-0.21	-0.34	-13.50	7.75	1.03	15.50
1	20	19.9	-0.47	-0.50	-14.47	8.14	1.43	17.53
1	0	0.1	-0.14	-0.12	-8.20	7.69	0.97	16.20
3	0	0.1	-0.14	-0.13	-8.10	8.68	1.97	16.10
3	10	9.8	-0.37	-0.37	-10.77	8.62	1.91	19.23
3	20	19.9	-0.56	-0.57	-9.20	8.71	2.00	15.80
10	0	0.1	-0.16	-0.16	-6.63	8.72	2.01	21.37
10	10	9.9	-0.38	-0.39	-6.60	8.48	1.76	17.40
10	20	19.8	-0.58	-0.58	-10.20	8.27	1.55	17.80

Summary of Slope Inclinometer Reading Events
Test Site 2, Pile 2

Test Date 12/14/94

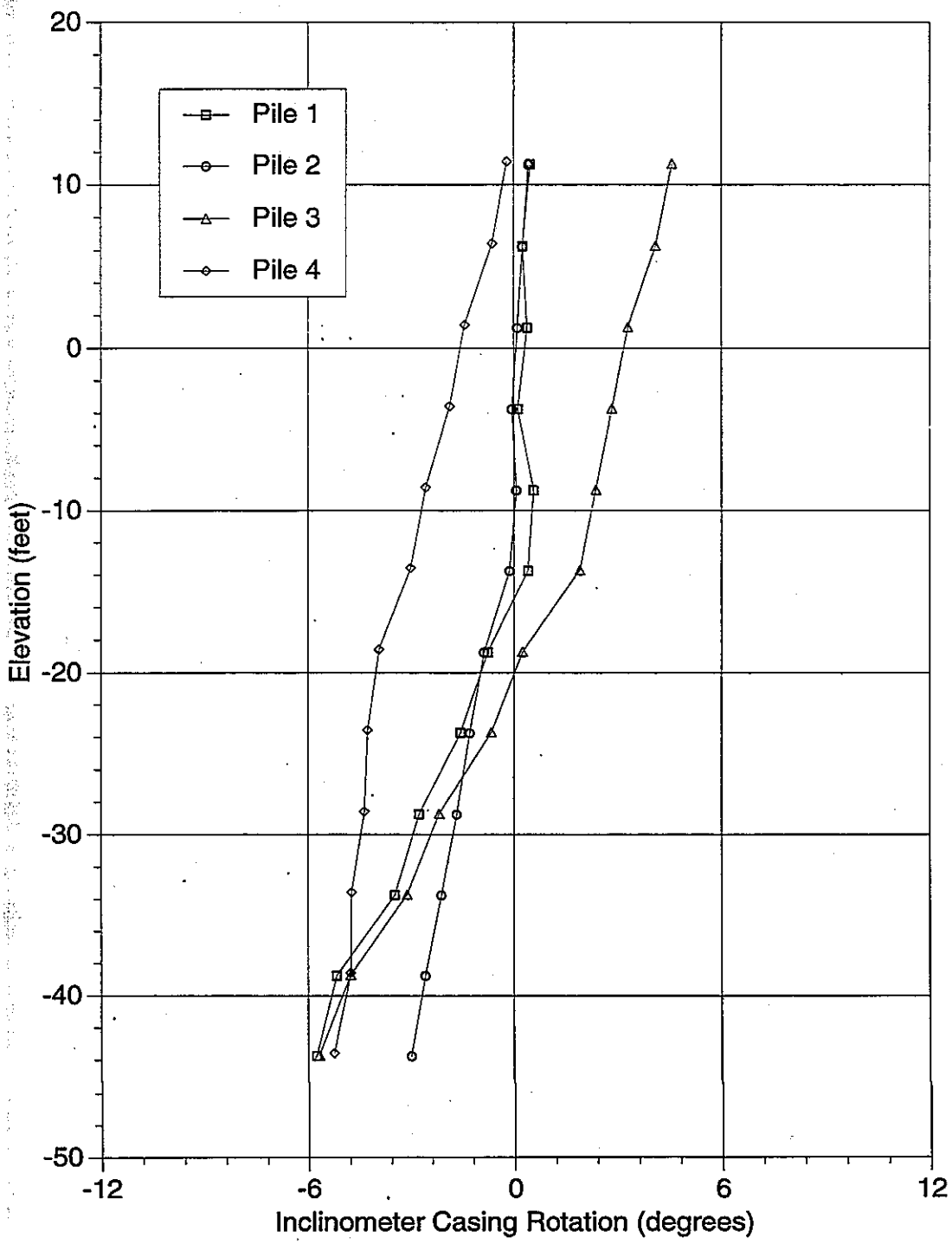
Slope Inclinometer Serial Number: 25864

Measurements in Direction of Applied Lateral Load (A-Direction)

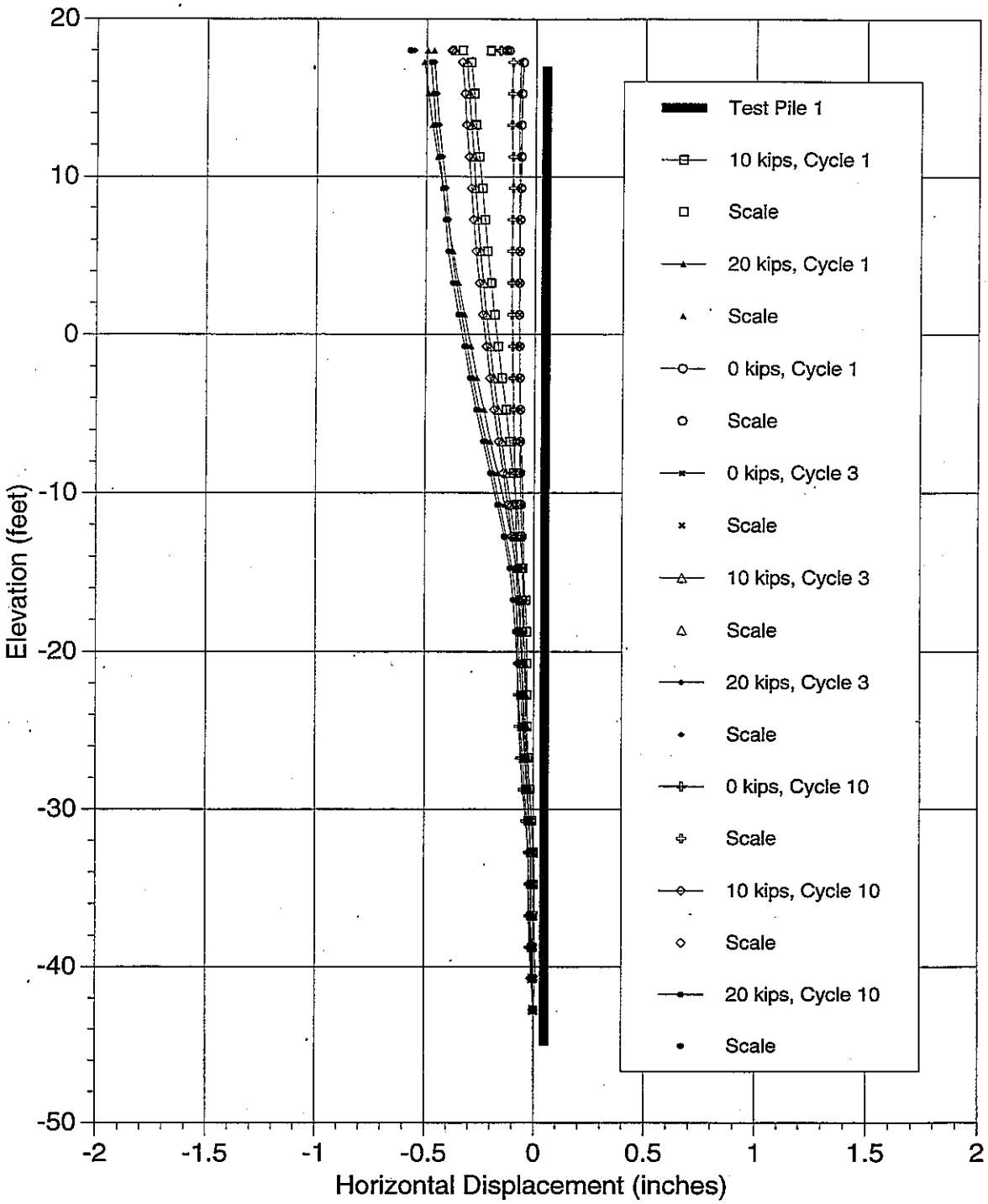
Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-9.24	5.51		
1	0	0.0			-6.45	5.15		
1	10	8.5	8.65	9.27	-9.97	4.75	0.40	9.97
1	20	16.3	17.89	19.04	-13.03	5.15	0.00	13.03
1	0	0.0	3.85	2.90	-5.00	4.13	1.02	13.00
3	0	0.0	3.98	3.44	-4.45	4.06	1.09	14.45
3	10	11.0	12.35	12.58	-6.34	4.25	0.90	10.66
3	20	22.8	20.08	20.57	-12.79	4.44	0.71	14.79
10	0	0.0	4.23	3.66	-3.97	5.03	0.12	14.97
10	10	10.3	13.10	13.16	-4.34	4.47	0.68	15.34
10	20	20.5	20.72	20.87	-6.83	4.46	0.69	9.83

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			0.10	5.27		
1	0	0.0			2.24	5.17		
1	10	8.5	0.60	0.63	5.14	5.42	0.25	11.86
1	20	16.3	1.48	1.43	5.66	5.85	0.68	12.66
1	0	0.0	0.29	0.25	3.66	4.82	0.35	11.66
3	0	0.0	0.28	0.34	4.21	5.18	0.00	9.79
3	10	11.0	0.95	0.96	4.07	5.91	0.74	13.07
3	20	22.8	1.52	1.55	4.03	6.22	1.05	16.03
10	0	0.0	0.35	0.35	4.28	6.70	1.53	14.28
10	10	10.3	1.02	1.02	5.31	6.14	0.97	16.69
10	20	20.5	1.57	1.57	4.34	7.40	2.23	20.34



Measured Rotation of Slope Inclinometer Casing
Test Site 2



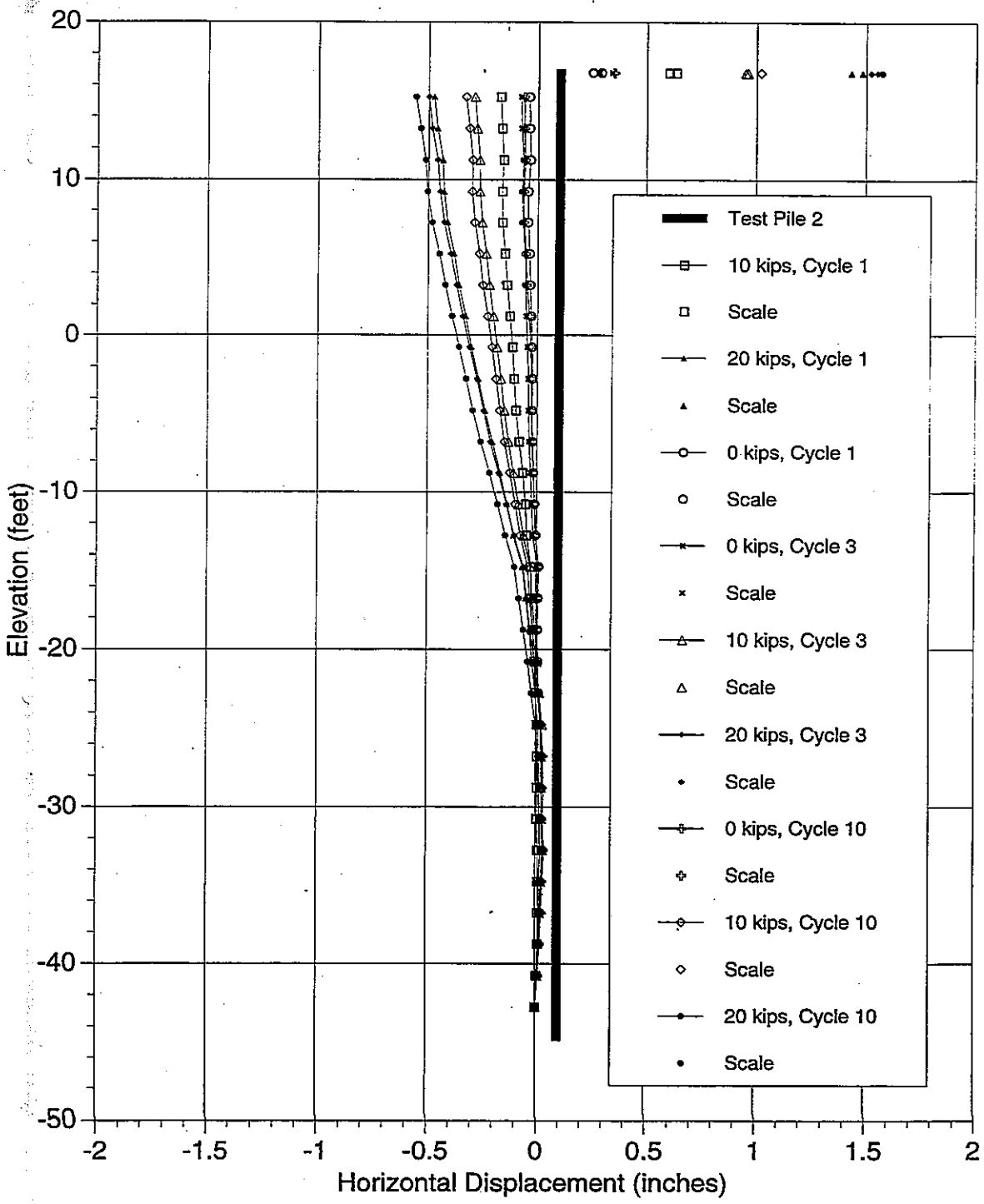
Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 12/1/94
Date Tested: 12/14/94
Installation Time: 4 hours 24 minutes

Ground Surface Elevation: 14.0 feet
Pile Top Elevation: 17.0 feet
Pile Tip Elevation: -45.0 feet
Bottom of Casing Elevation: -14.0 feet
Top of Mud Line Elevation: -11.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 2, Pile 1



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/28/94

Date Tested: 12/14/94

Installation Time: 4 hours 52 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -44.9 feet

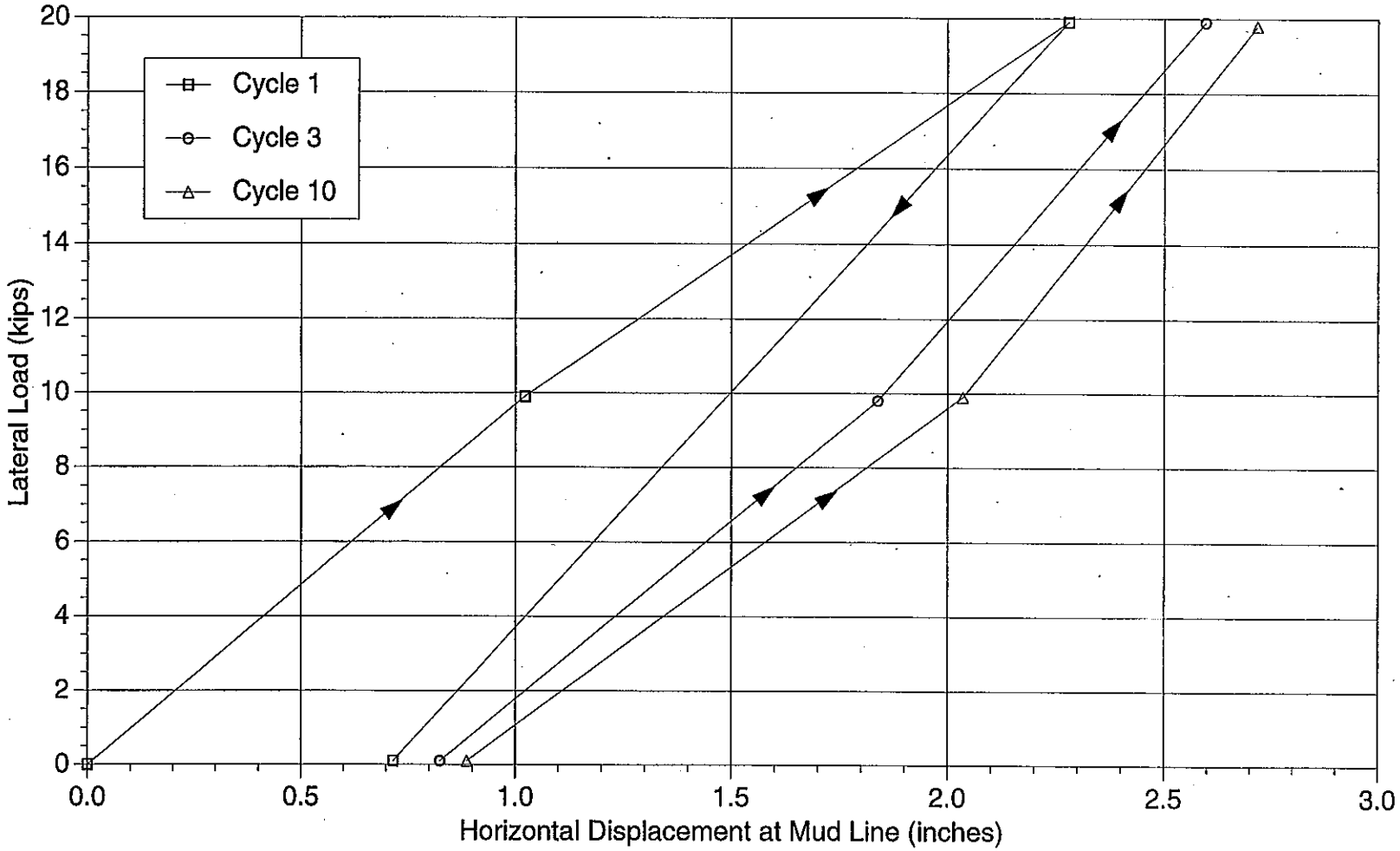
Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -12.1 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 2, Pile 2



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 12/1/94

Date Tested: 12/14/94

Installation Time: 4 hours 24 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

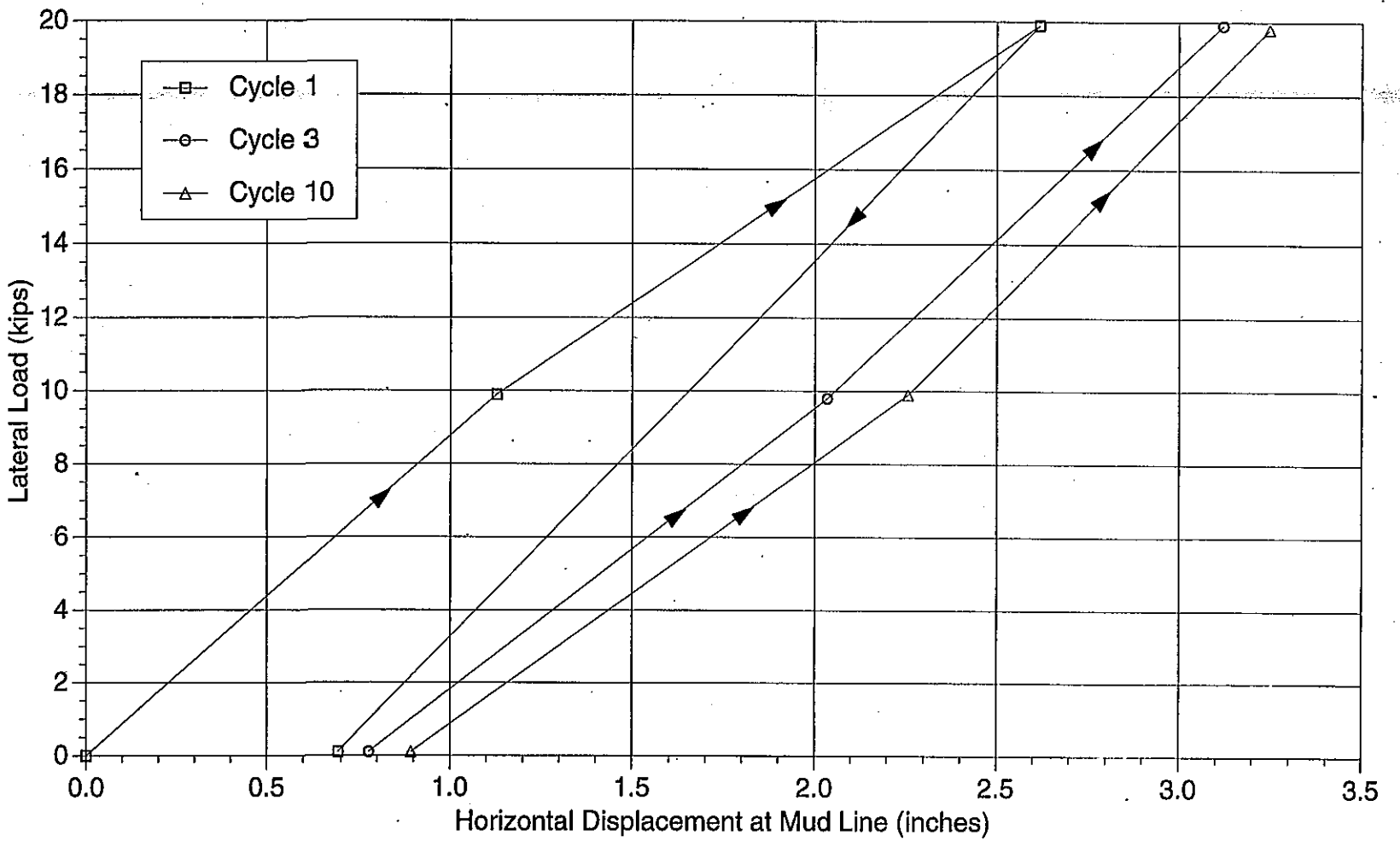
Pile Tip Elevation: -45.0 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Lateral Load - Displacement at Mud Line

Test Site 2, Pile 1



Pile Type: Fundex PP 20x0.5

Grout Volume: 320 gallons

Date Installed: 11/28/94

Date Tested: 12/14/94

Installation Time: 4 hours 52 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

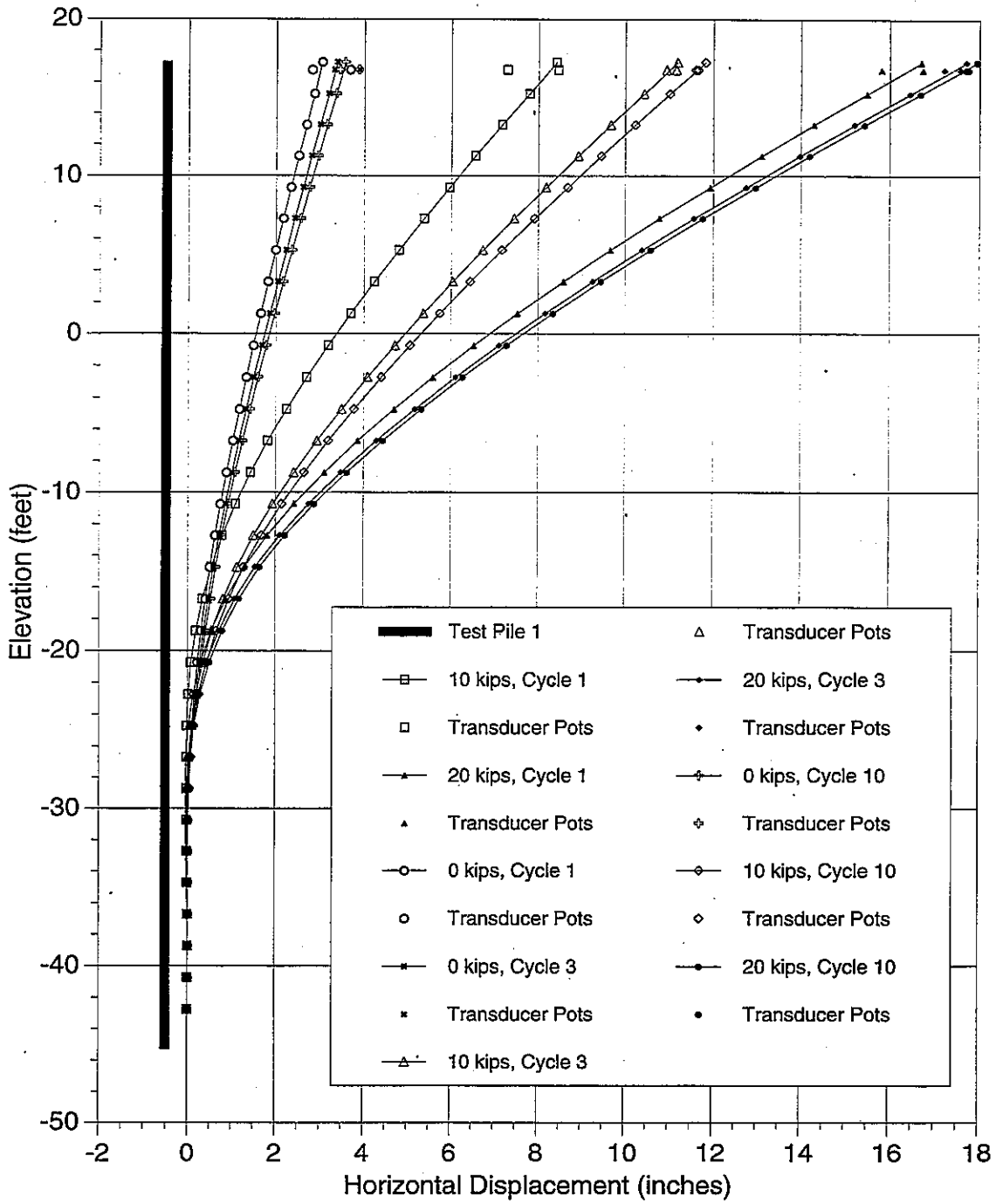
Pile Tip Elevation: -44.9 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -12.1 feet

Lateral Load - Displacement at Mud Line

Test Site 2, Pile 2



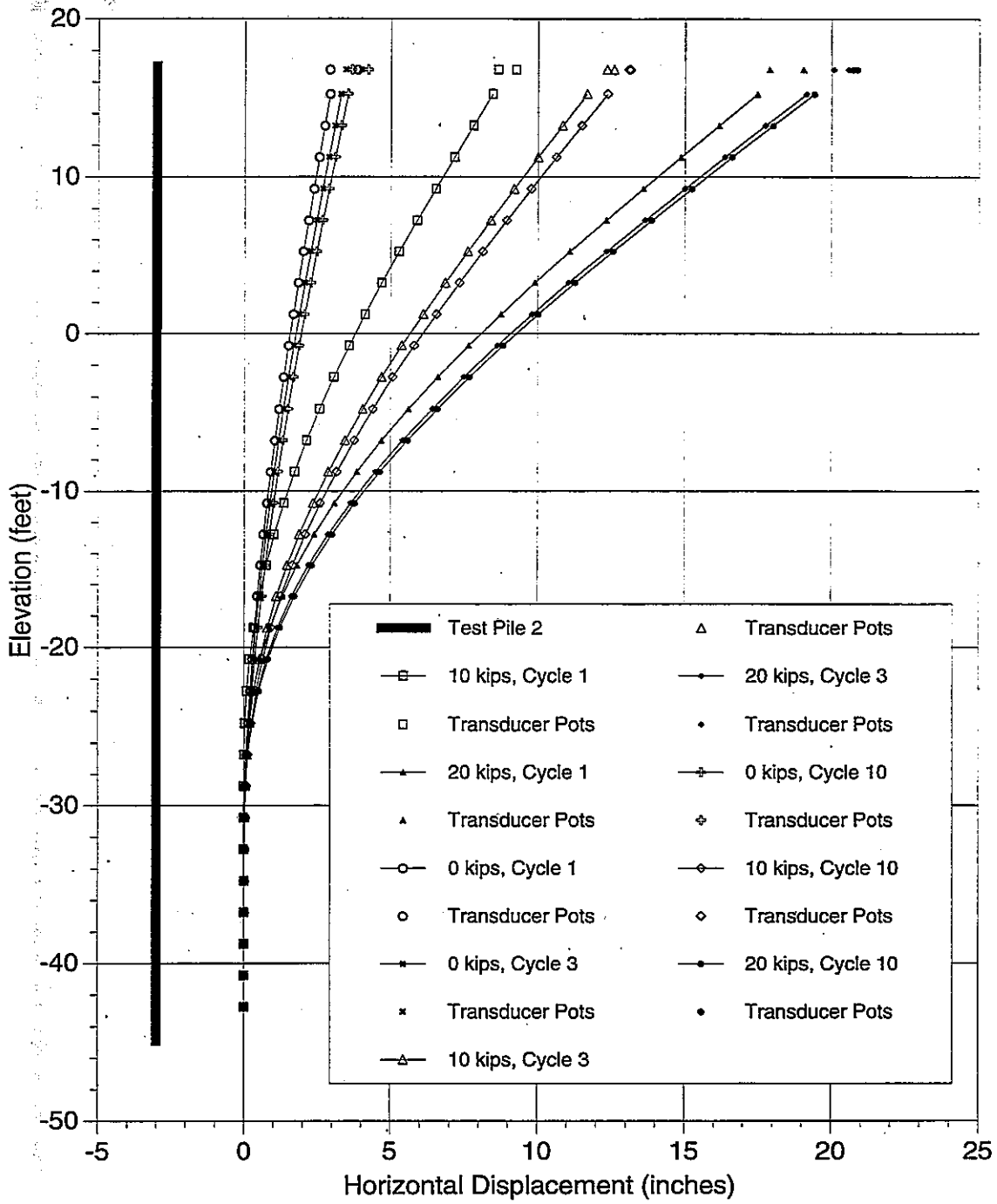
Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 12/1/94
Date Tested: 12/14/94
Installation Time: 4 hours 24 minutes

Ground Surface Elevation: 14.0 feet
Pile Top Elevation: 17.0 feet
Pile Tip Elevation: -45.0 feet
Bottom of Casing Elevation: -14.0 feet
Top of Mud Line Elevation: -11.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 2, Pile 1



Pile Type: Fundex PP 20x0.5
Grout Volume: 320 gallons
Date Installed: 11/28/94
Date Tested: 12/14/94
Installation Time: 4 hours 52 minutes

Ground Surface Elevation: 14.0 feet
Pile Top Elevation: 17.0 feet
Pile Tip Elevation: -44.9 feet
Bottom of Casing Elevation: -14.0 feet
Top of Mud Line Elevation: -12.1 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 2, Pile 2

INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

Appendix H

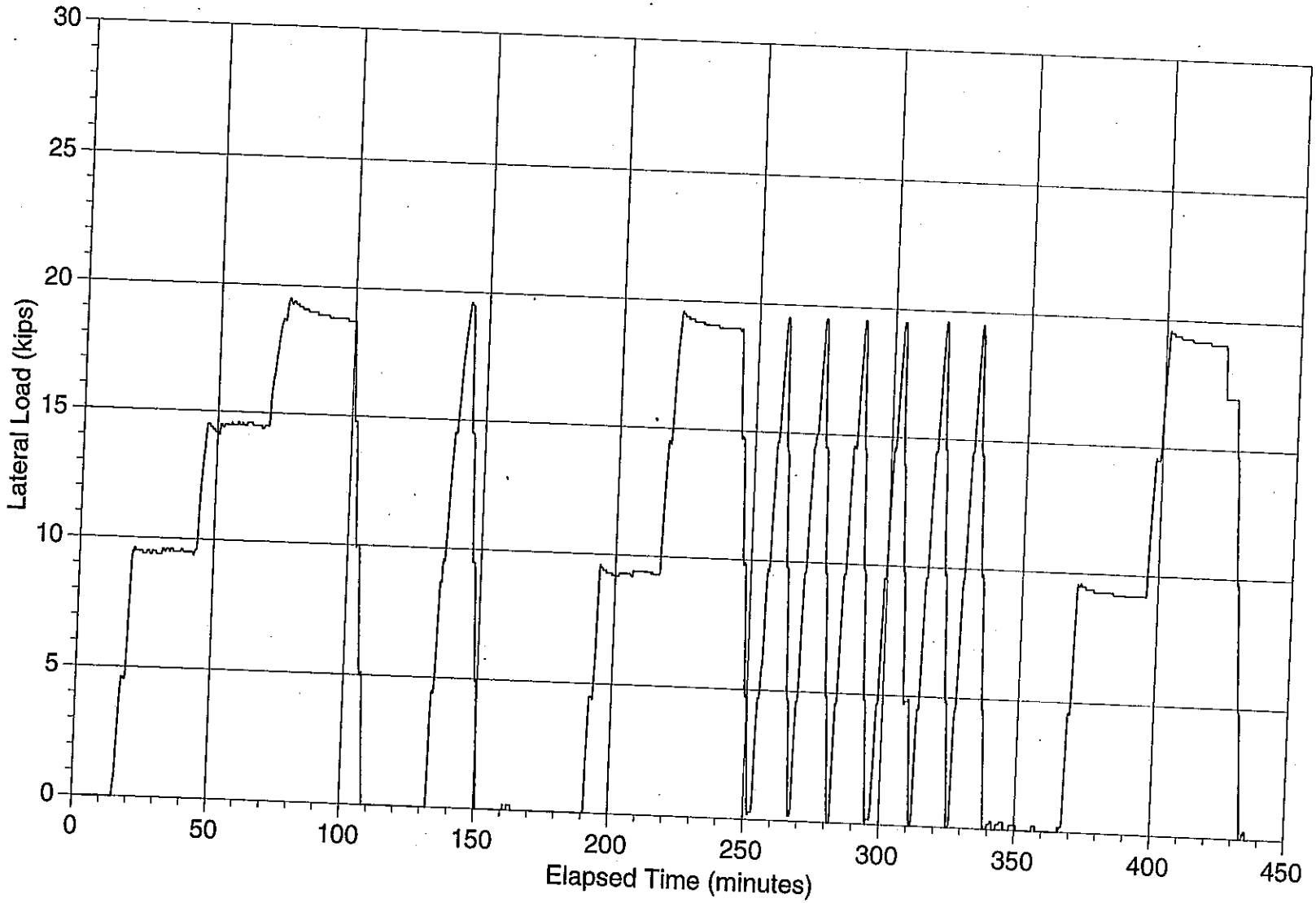
Site 2
Piles 3 and 4
Lateral Load Test Plots

Top: Installing driven pipe pile (PP24 x 0.75) at Site 1 with a Vulcan 80C Double Acting Air Hammer

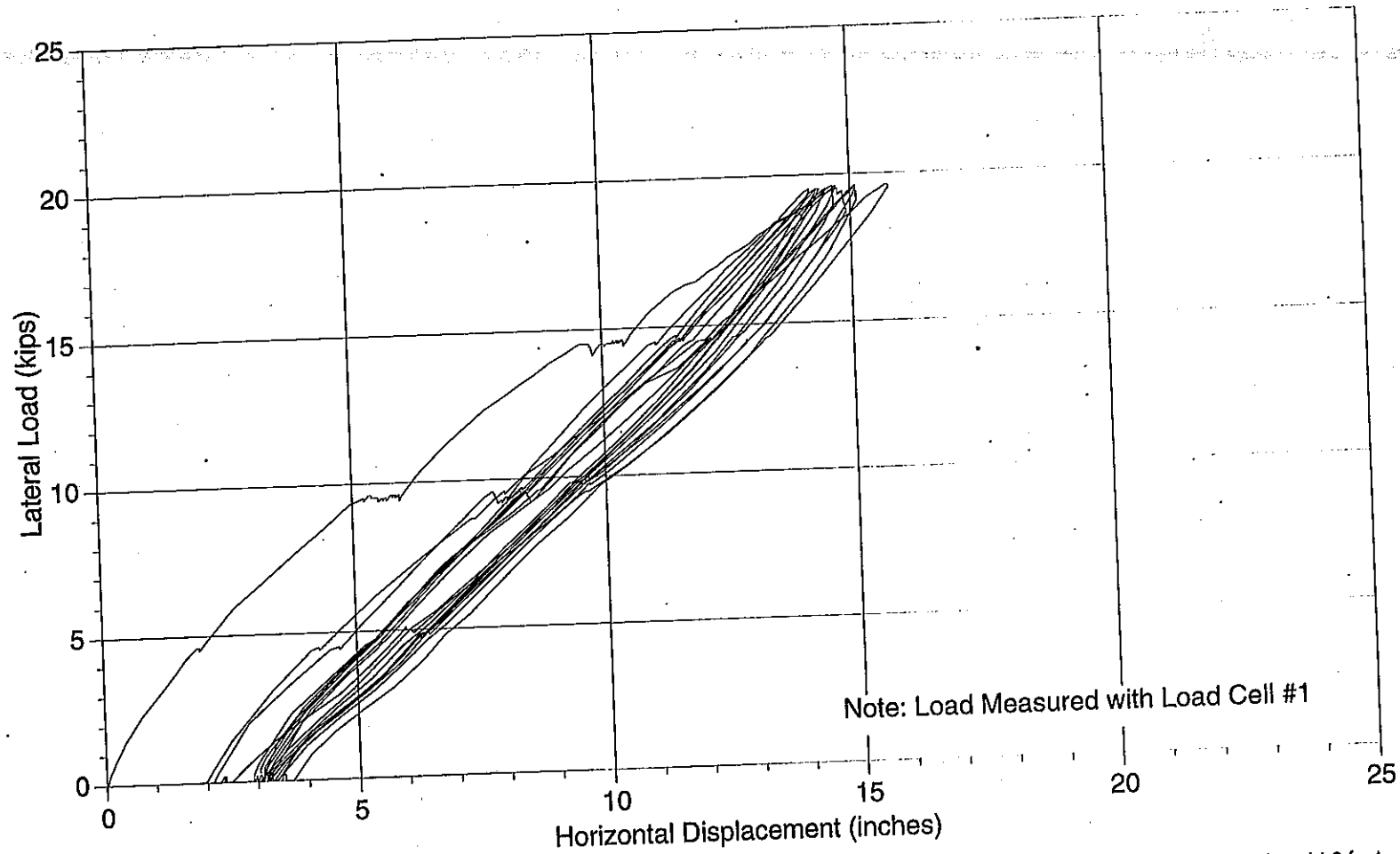
Middle: Performing axial static tension test on the driven pile at Site 1.

Bottom: View of the home made Centralizer used to center the grout pipe and offset the Slope Inclinometer Casing.

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995



Lateral Load - Time History
Test Site 2, Pile 3 and Pile 4



Pile Type: Fundex PP 20x0.5 (-45' to -8.0') PP 20x0.75 (-8.0' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 4 hours 29 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

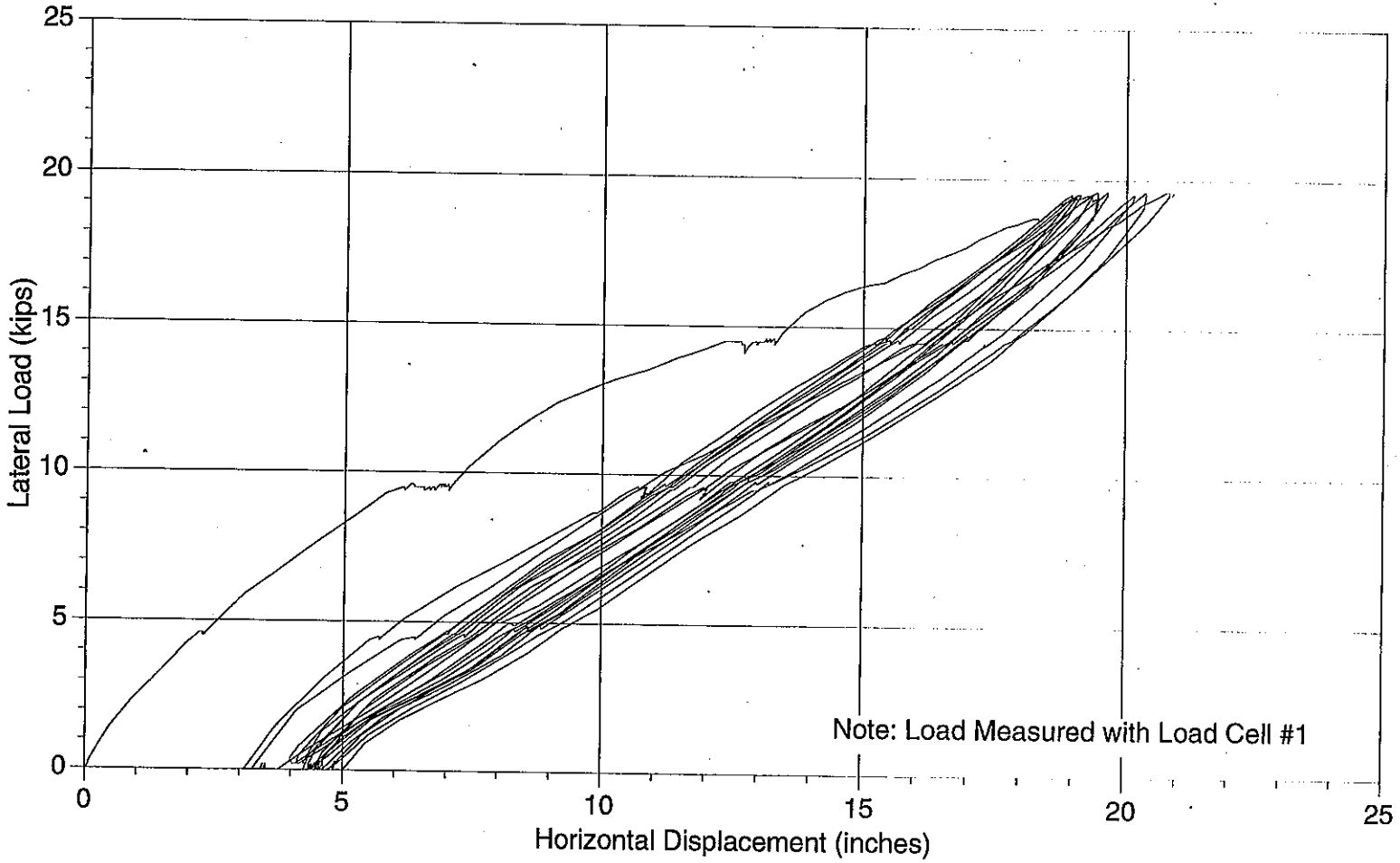
Pile Tip Elevation: -45.0 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -10.2 feet

Lateral Load - Displacement Near Pile Top

Test Site 2, Pile 3



Pile Type: Fundex PP 20x0.5 (-45.5' to -8.5') PP 20x0.75 (-8.5' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 3 hours 55 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -45.5 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Lateral Load - Displacement Near Pile Top

Test Site 2, Pile 4

Summary of Slope Inclinometer Reading Events
Test Site 2, Pile 3

Test Date 12/15/94

Slope Inclinometer Serial Number: 27444

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			3.83	2.44		
1	0	0.0			4.57	1.89		
1	10	9.5	5.23	6.01	-0.33	5.36	3.46	11.67
1	15	14.5	9.55	10.47	-0.67	6.62	4.73	10.33
1	20	19.0	14.44	14.92	5.97	3.14	1.24	6.03
1	0	0.0	2.47	1.96	8.23	2.56	0.67	7.23
3	0	0.0	2.73	2.11	8.90	3.49	1.59	7.90
3	10	9.3	7.80	8.10	2.83	4.06	2.17	8.83
3	20	19.1	14.55	14.67	6.53	2.12	0.23	4.53
10	0	0.1	3.34	2.91	5.53	3.37	1.48	7.53
10	10	9.3	8.32	8.54	3.97	2.52	0.63	6.97
10	20	19.2	15.10	15.13	6.03	2.92	1.02	9.97

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-11.97	7.64		
1	0	0.0			-11.23	6.37		
1	10	9.5	0.00	0.00	-9.40	6.29	0.08	13.60
1	15	14.5	-0.12	-0.12	-8.97	6.68	0.31	14.03
1	20	19.0	-0.12	-0.12	-9.00	7.44	1.07	16.00
1	0	0.0	0.00	0.00	-9.00	6.72	0.35	12.00
3	0	0.0	0.00	0.00	-11.97	6.19	0.18	14.03
3	10	9.3	-0.07	-0.07	-9.53	7.09	0.72	13.47
3	20	19.1	-0.11	-0.11	-11.93	7.57	1.20	16.07
10	0	0.1	0.00	0.00	-15.60	7.46	1.09	17.40
10	10	9.3	-0.02	-0.02	-11.73	6.14	0.23	10.73
10	20	19.2	-0.13	-0.16	-11.70	6.97	0.60	20.30

Summary of Slope Inclinometer Reading Events
Test Site 2, Pile 4

Test Date 12/15/94

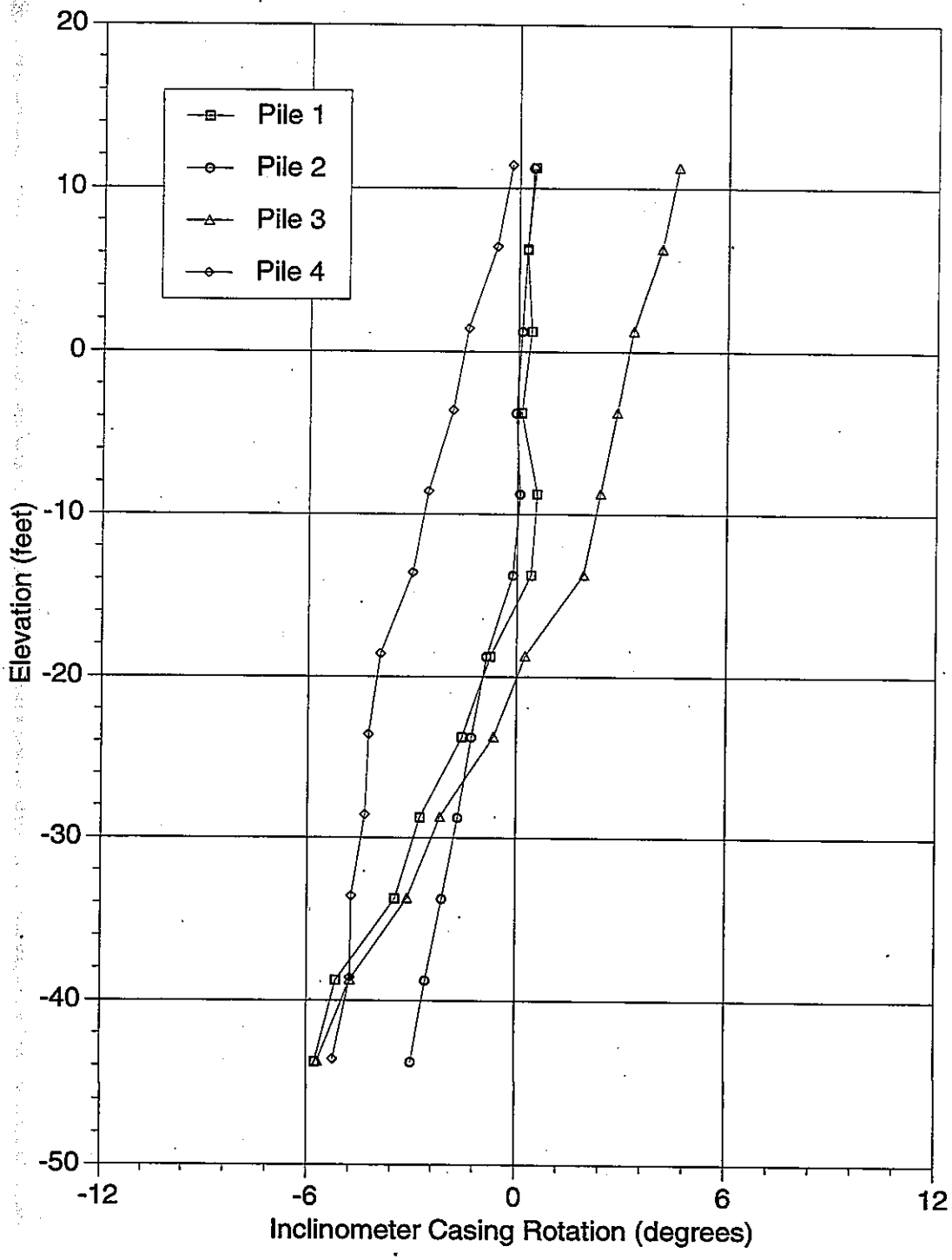
Slope Inclinometer Serial Number: 25690

Measurements in Direction of Applied Lateral Load (A-Direction)

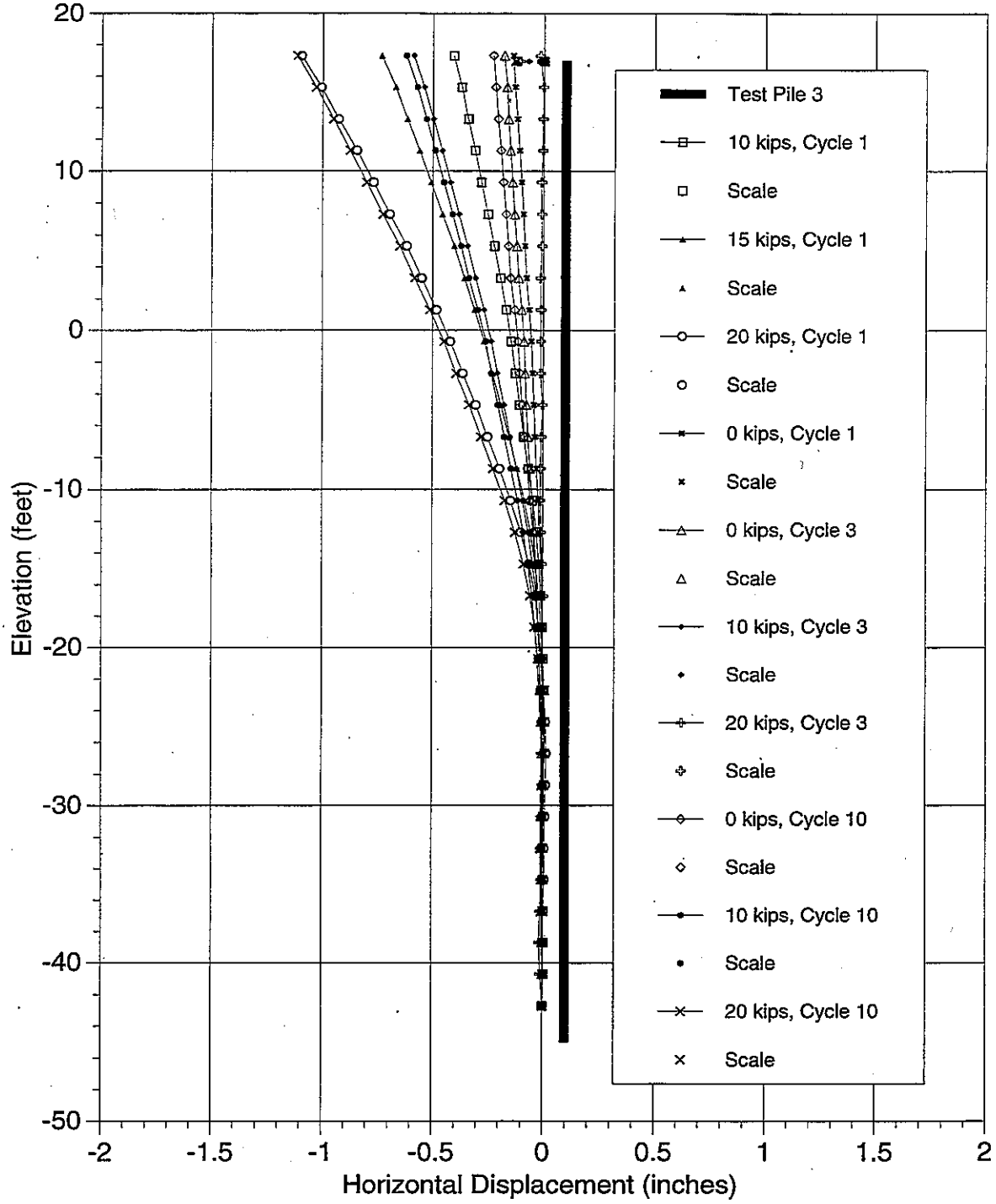
Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			0.21	2.70		
1	0	0.0			-1.03	3.08		
1	10	8.1	6.14	7.10	-8.93	6.34	3.26	17.93
1	15	14.0	12.34	13.33	-7.38	5.47	2.39	13.38
1	20	19.2	18.86	19.34	1.83	4.82	1.74	8.17
1	0	0.0	3.75	3.09	3.62	2.48	0.60	5.62
3	0	0.0	3.90	3.26	1.83	2.90	0.18	8.83
3	10	8.2	10.85	10.91	-2.79	3.28	0.20	9.21
3	20	18.1	19.31	19.43	0.24	3.95	0.87	7.24
10	0	0.0	4.69	4.34	3.24	4.01	0.94	9.24
10	10	8.2	11.96	11.89	0.86	3.38	0.30	6.86
10	20	17.8	20.37	20.33	-0.24	4.16	1.08	9.76

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			44.72	8.29		
1	0	0.0			45.45	9.17		
1	10	8.1	0.29	0.34	45.79	10.59	7.51	39.79
1	15	14.0	0.43	0.67	47.17	11.48	8.40	42.17
1	20	19.2	1.03	1.05	46.31	11.68	8.60	44.31
1	0	0.0	0.15	0.15	45.38	9.39	6.31	35.38
3	0	0.0	0.15	0.11	45.24	8.70	5.62	27.24
3	10	8.2	0.50	0.49	45.66	12.28	9.21	38.66
3	20	18.1	0.89	0.88	45.59	13.19	10.11	53.59
10	0	0.0	0.08	0.07	46.93	8.83	5.75	35.93
10	10	8.2	0.49	0.48	47.03	11.02	7.94	45.03
10	20	17.8	0.93	0.94	45.79	12.08	9.00	51.79



Measured Rotation of Slope Inclinometer Casing
Test Site 2



Pile Type: Fundex PP 20x0.5 (-45' to -8.0') PP 20x0.75 (-8.0' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 4 hours 29 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -45.0 feet

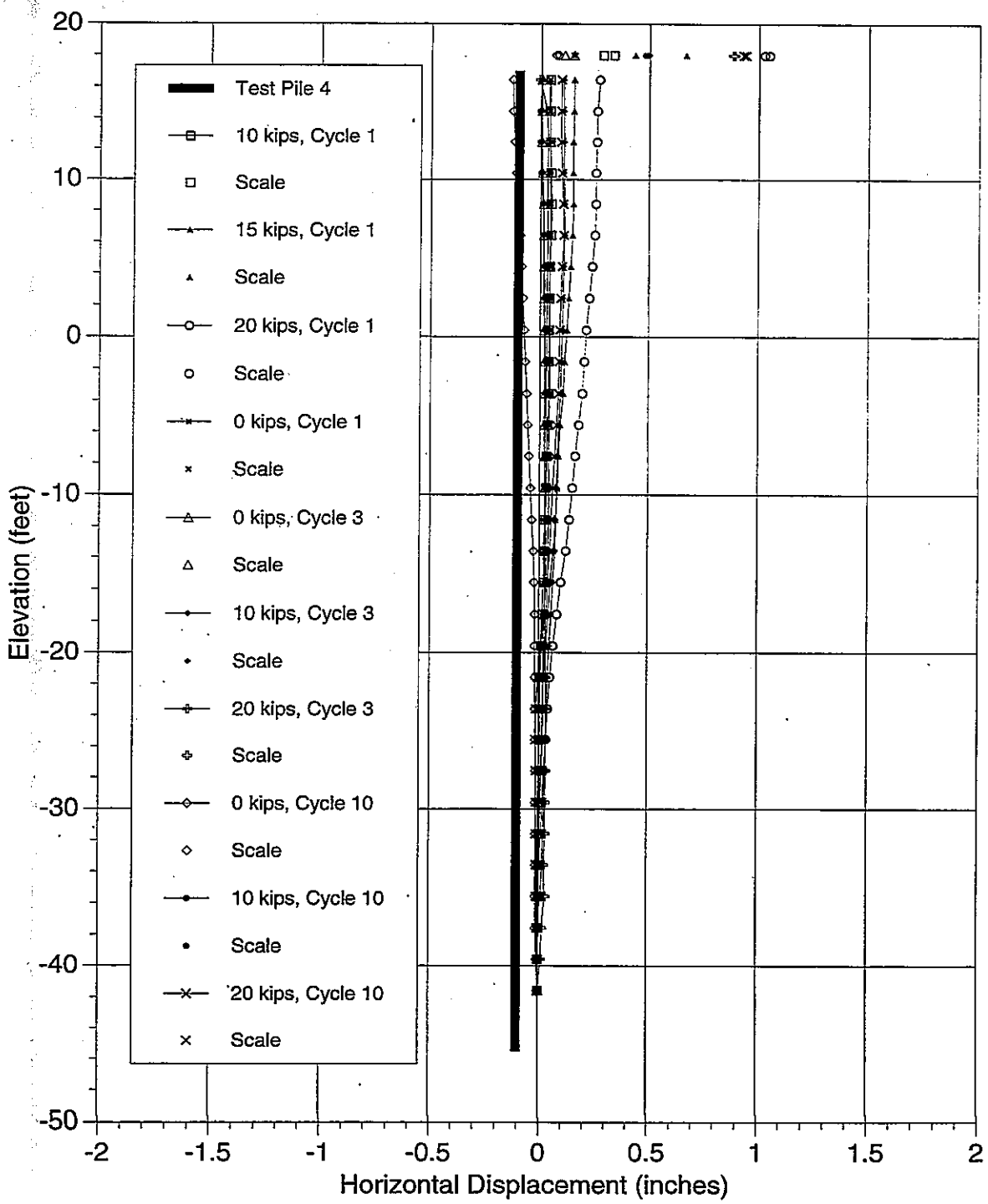
Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -10.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 2, Pile 3



Pile Type: Fundex PP 20x0.5 (-45.5' to -8.5') PP 20x0.75 (-8.5' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 3 hours 55 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -45.5 feet

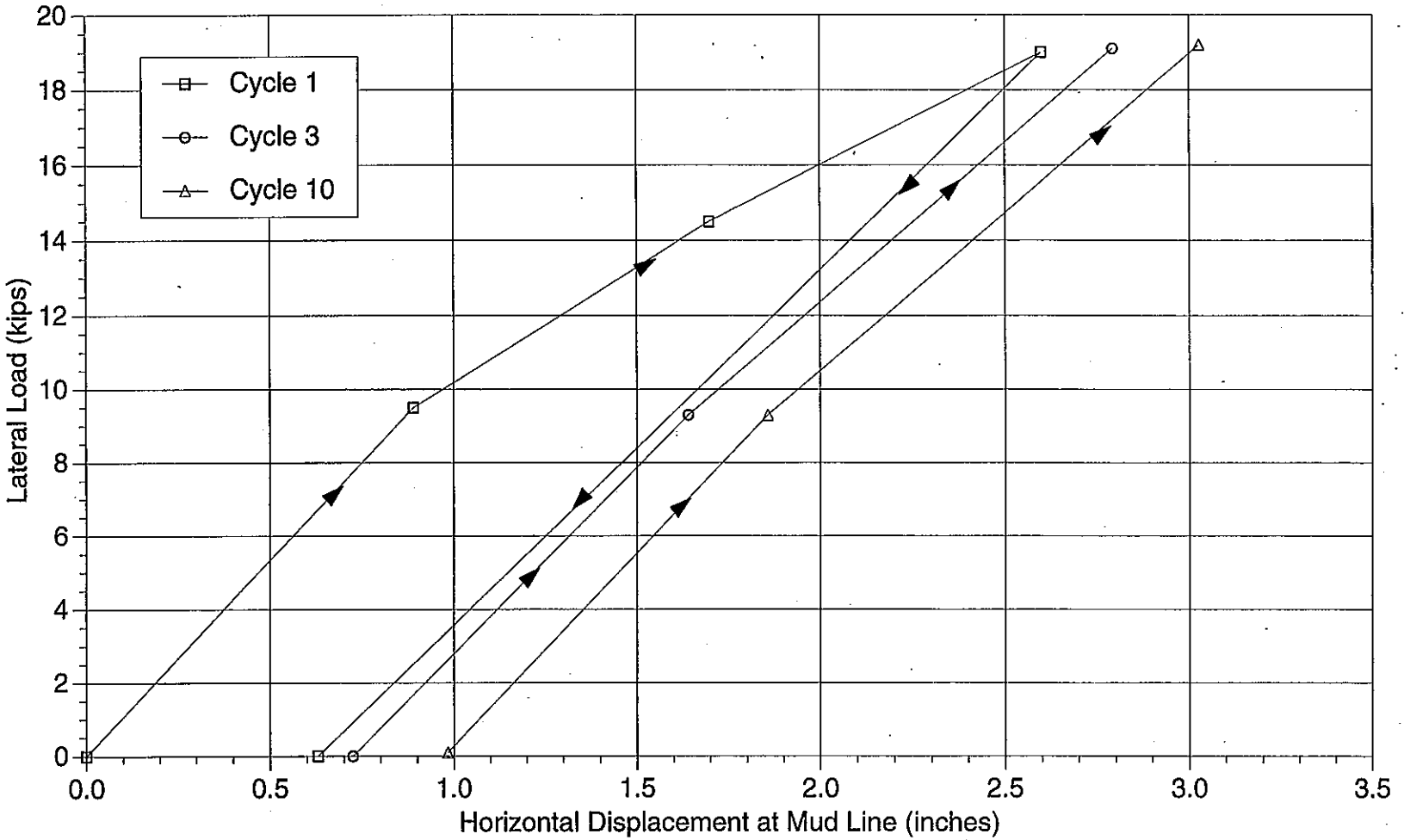
Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 2, Pile 4



Pile Type: Fundex PP 20x0.5 (-45' to -8.0') PP 20x0.75 (-8.0' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 4 hours 29 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

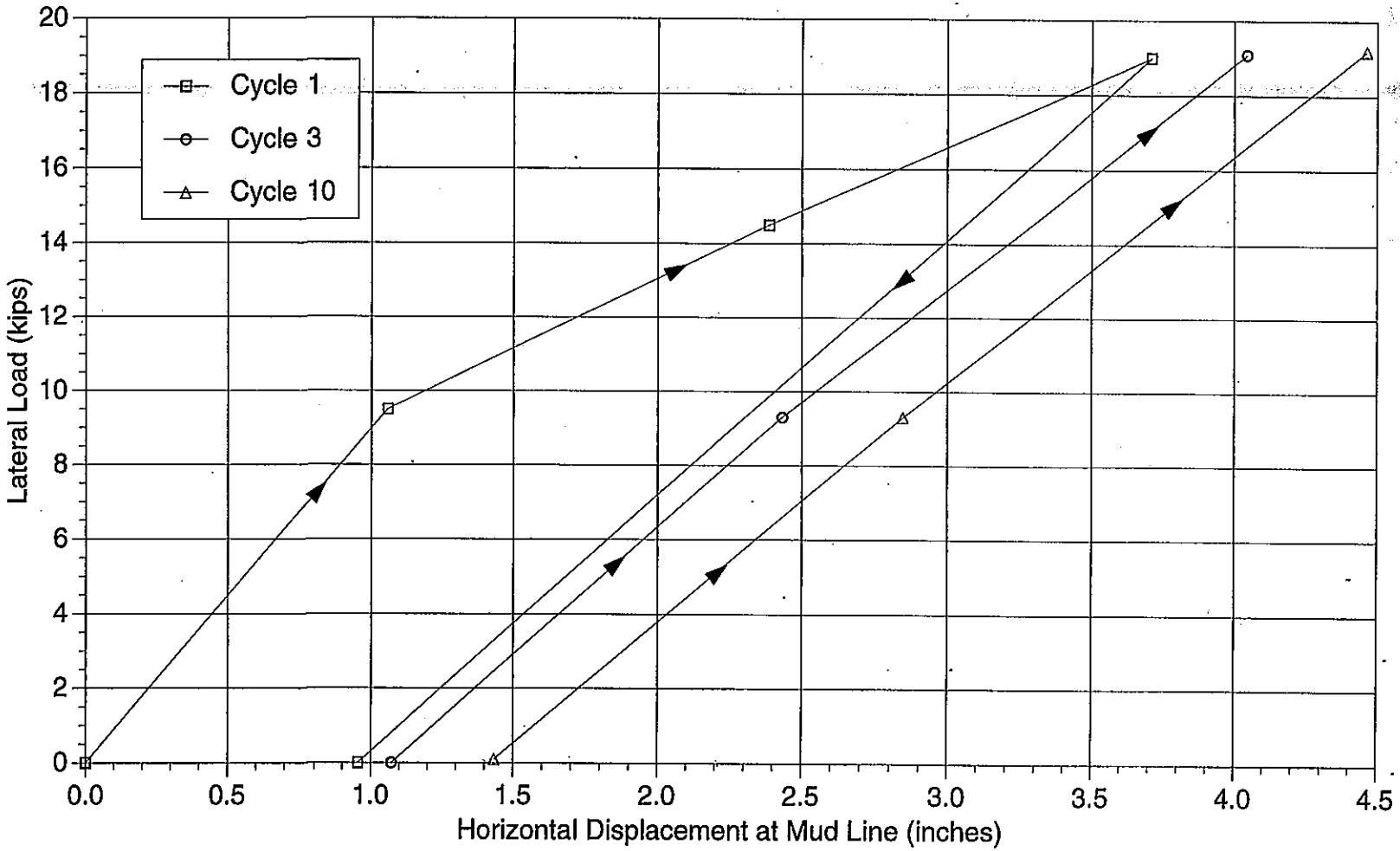
Pile Tip Elevation: -45.0 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -10.2 feet

Lateral Load - Displacement at Mud Line

Test Site 2, Pile 3



Pile Type: Fundex PP 20x0.5 (-45.5' to -8.5') PP 20x0.75 (-8.5' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 3 hours 55 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

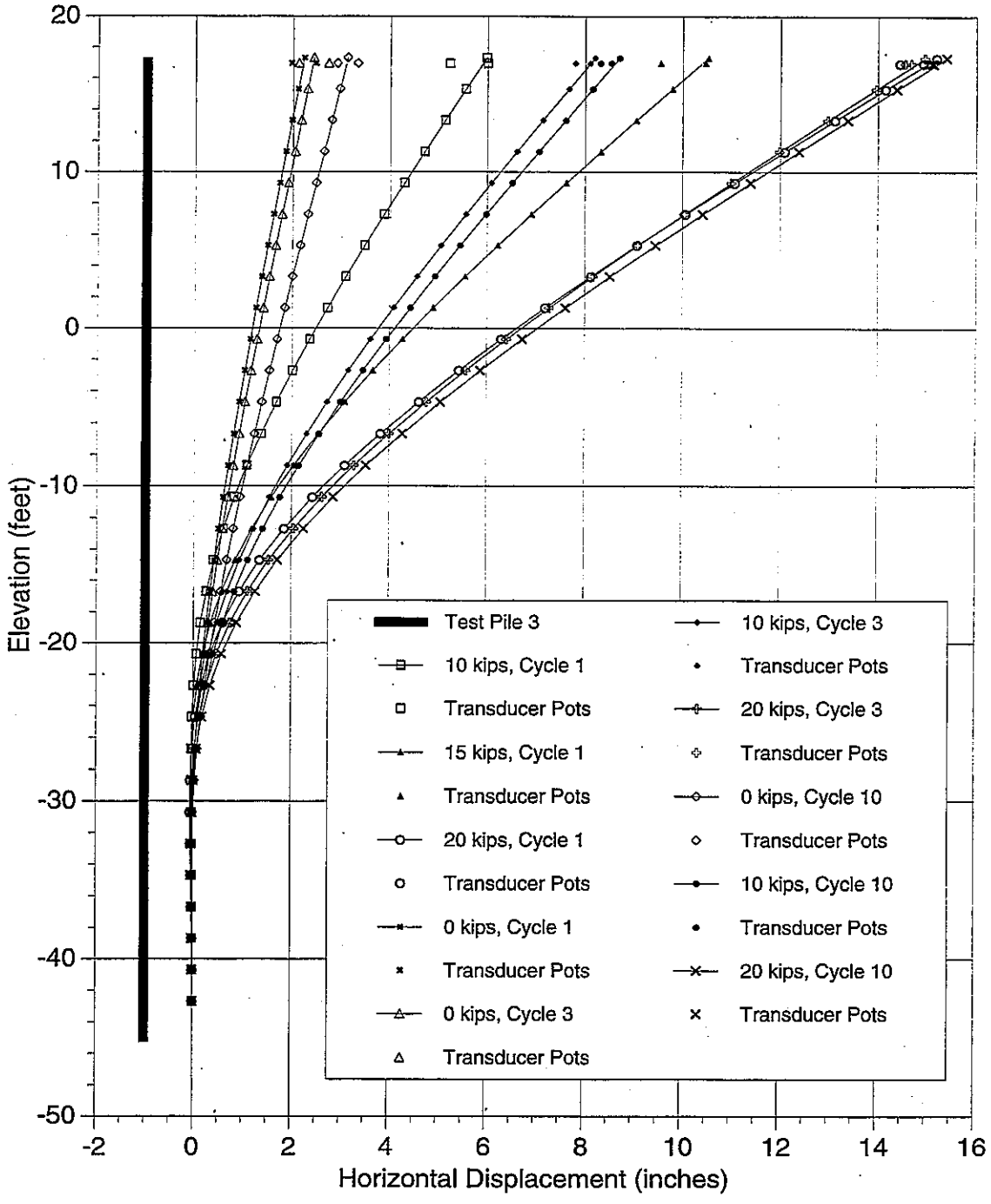
Pile Tip Elevation: -45.5 feet

Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -11.2 feet

Lateral Load - Displacement at Mud Line

Test Site 2, Pile 4



Pile Type: Fundex PP 20x0.5 (-45' to -8.0') PP 20x0.75 (-8.0' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 4 hours 29 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -45.0 feet

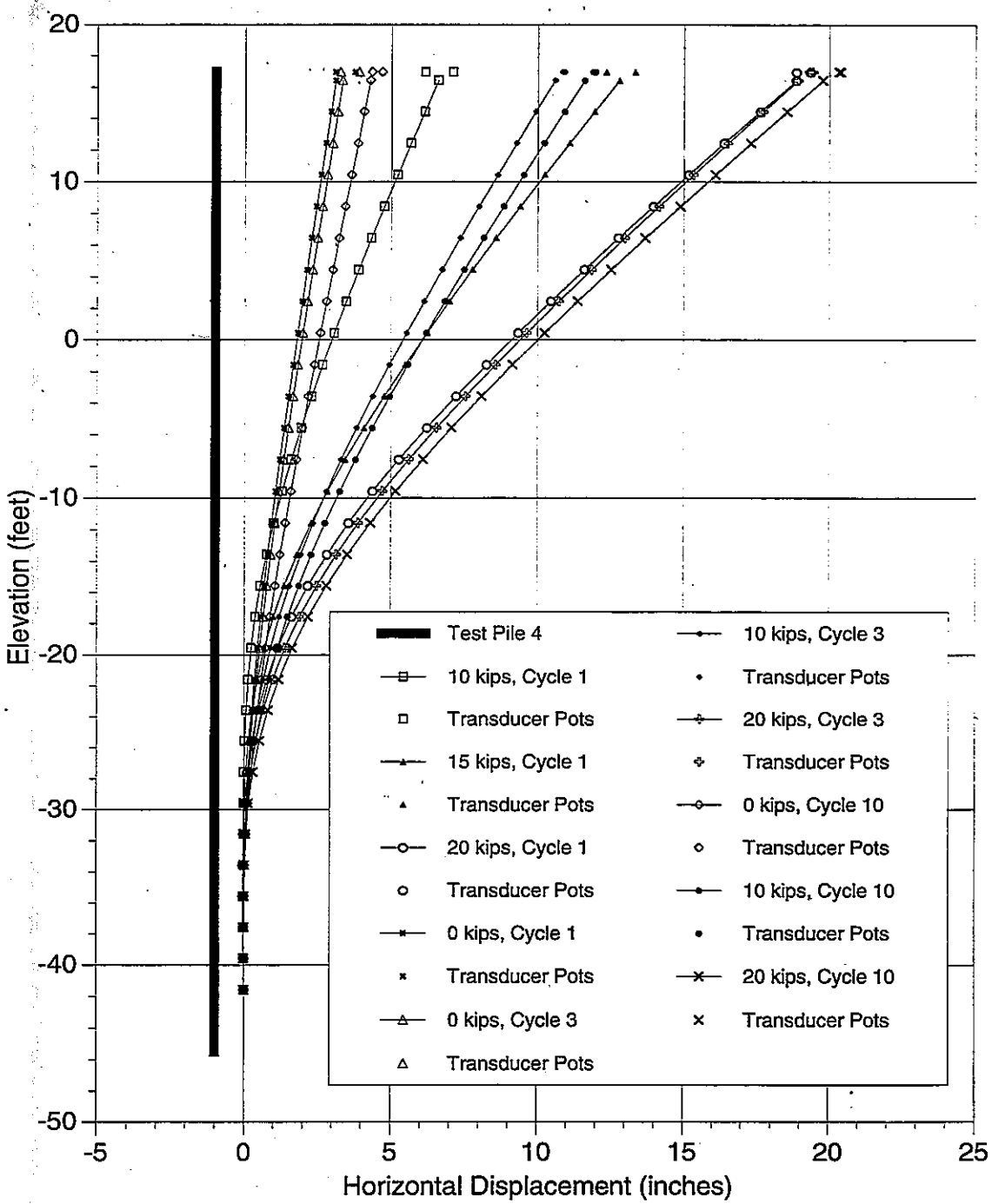
Bottom of Casing Elevation: -14.0 feet

Top of Mud Line Elevation: -10.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 2, Pile 3



Pile Type: Fundex PP 20x0.5 (-45.5' to -8.5') PP 20x0.75 (-8.5' to 17.0')

Grout Volume: 240 gallons

Date Installed: 11/30/94

Date Tested: 12/15/94

Installation Time: 3 hours 55 minutes

Ground Surface Elevation: 14.0 feet

Pile Top Elevation: 17.0 feet

Pile Tip Elevation: -45.5 feet

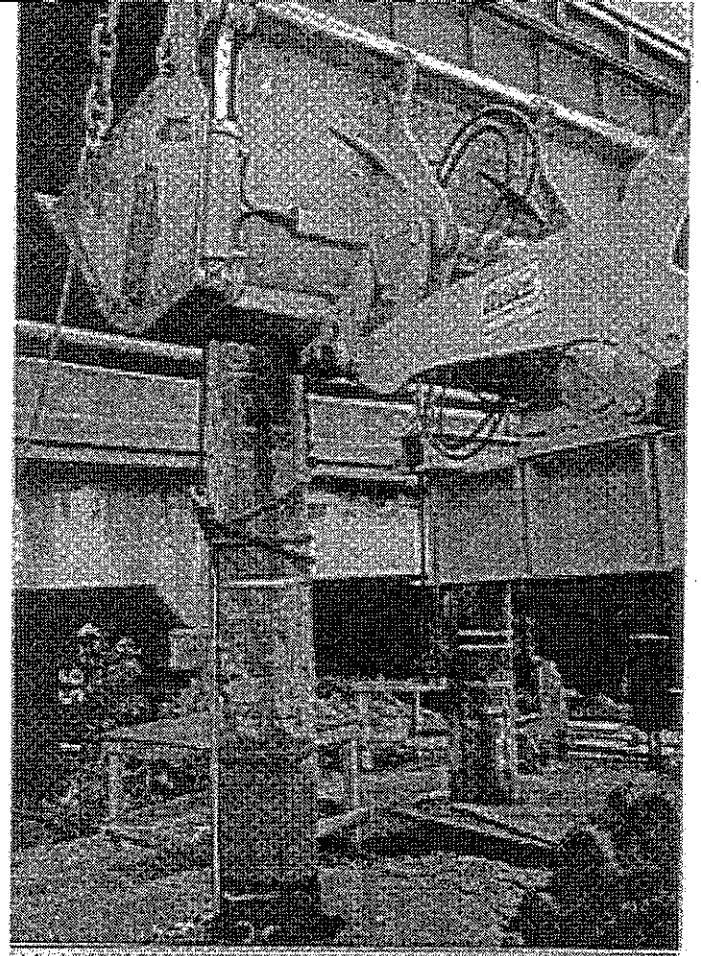
Bottom of Casing Elevation: -14.0 feet

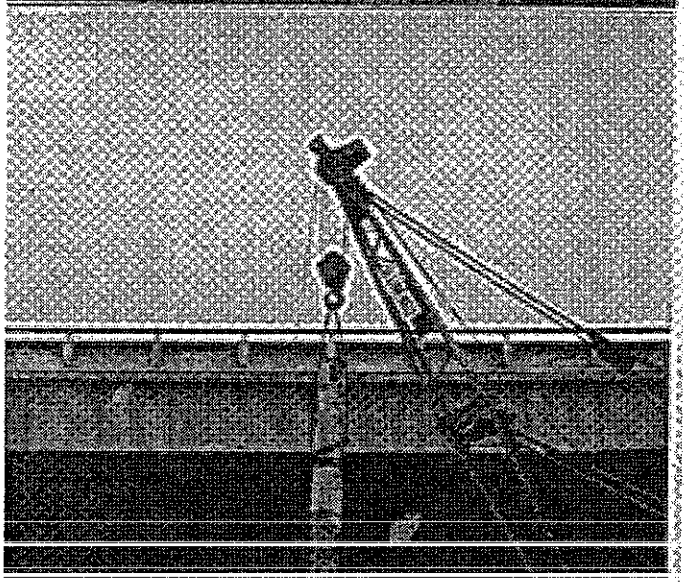
Top of Mud Line Elevation: -11.2 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 2, Pile 4





INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

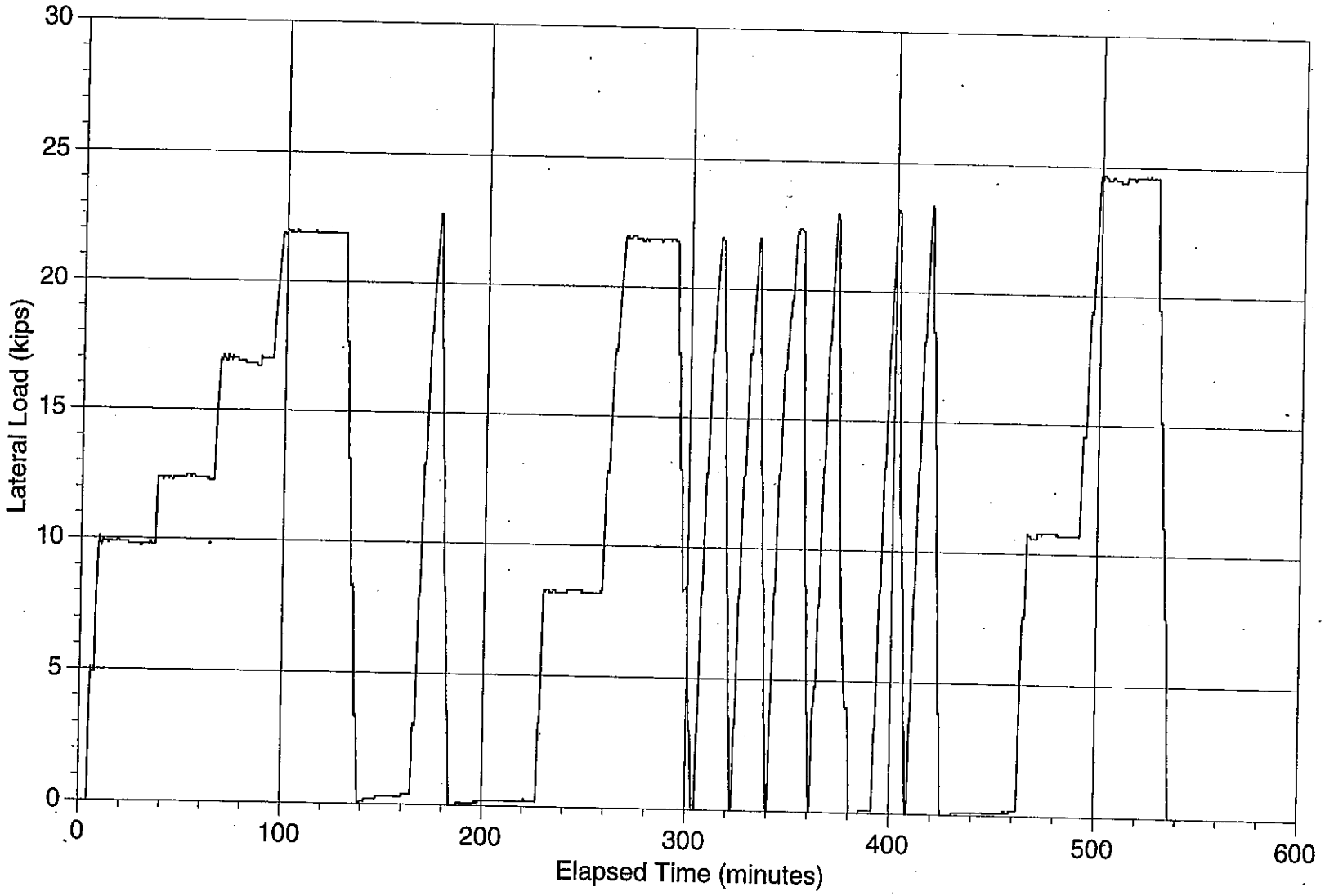
Appendix I

Site 3
Piles 1 and 2
Lateral Load Test Plots

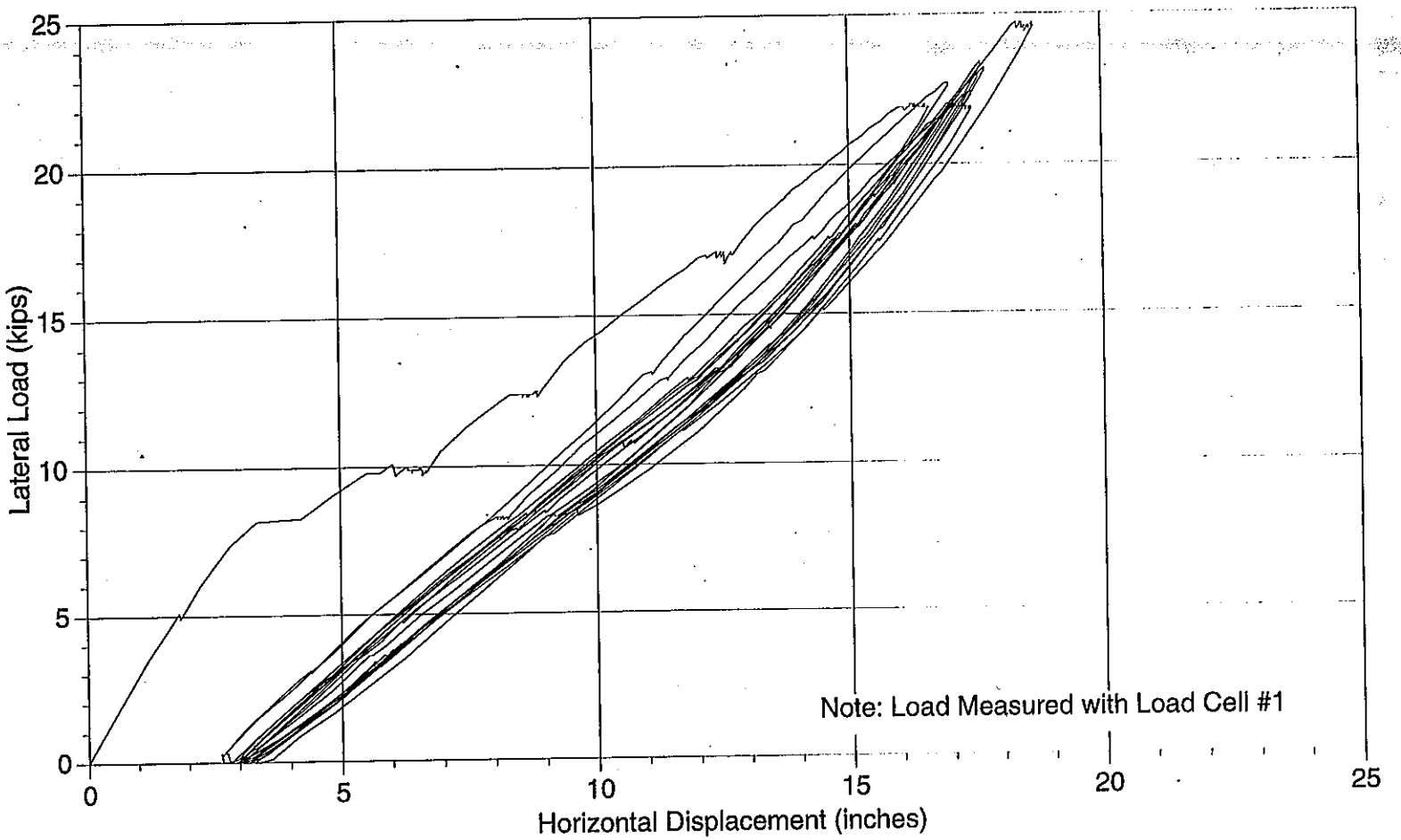
Top: Pile extraction with a 45 ton crane and a loader at Site 1

Bottom: End of Pile Extraction

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995



Lateral Load - Time History
Test Site 3, Pile 1 and Pile 2



Pile Type: Fundex PP 20x0.5

Grout Volume: 400 gallons

Date Installed: 12/6/94

Date Tested: 12/19/94

Installation Time: 6 hours 13 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

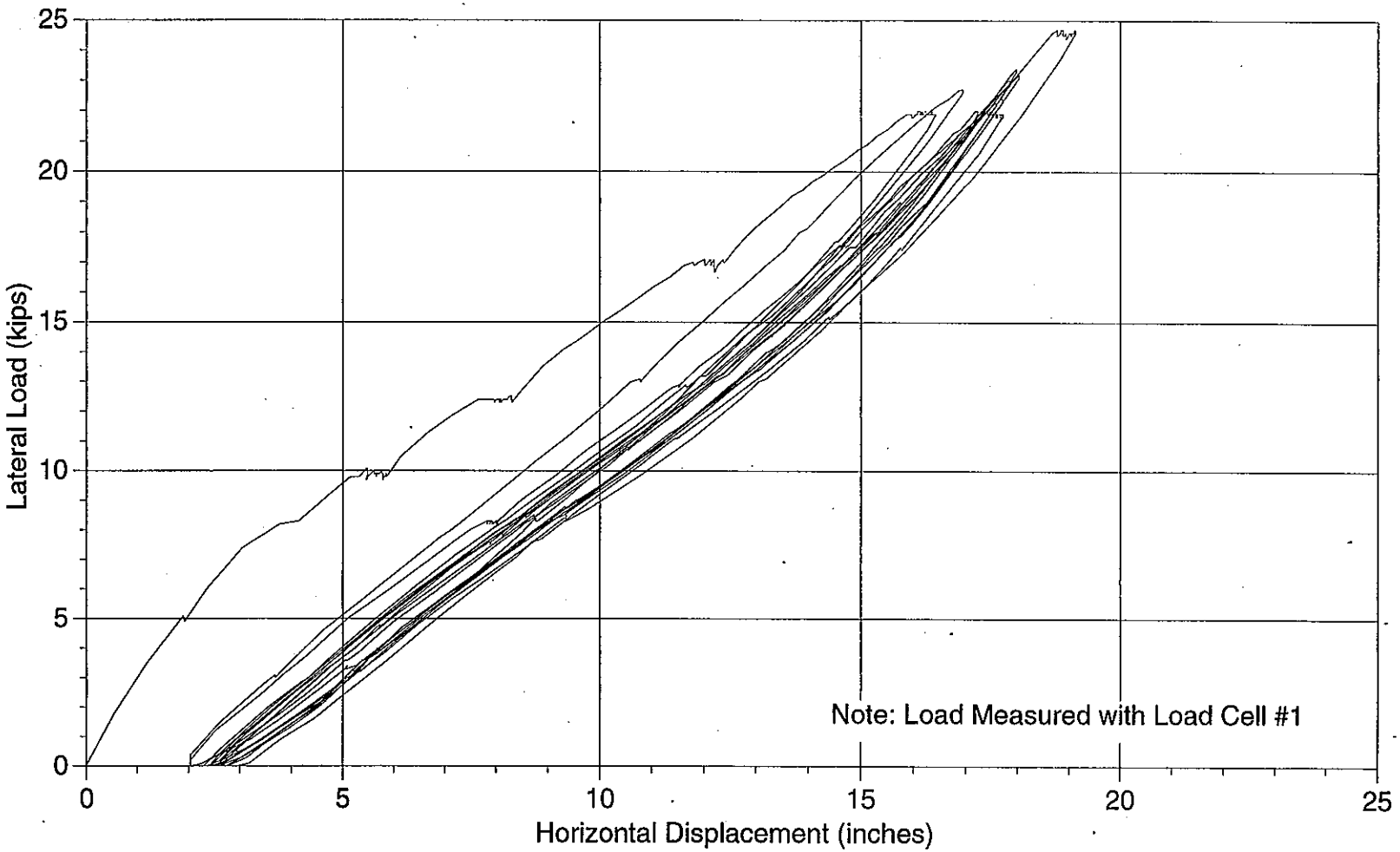
Pile Tip Elevation: -64.8 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -12.8 feet

Lateral Load - Displacement Near Pile Top

Test Site 3, Pile 1



Pile Type: Fundex PP 20x0.5

Grout Volume: 400 gallons

Date Installed: 12/8/94

Date Tested: 12/19/94

Installation Time: 5 hours 54 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

Pile Tip Elevation: -65.0 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -13.6 feet

Lateral Load - Displacement Near Pile Top

Test Site 3, Pile 2

Summary of Slope Inclinometer Reading Events
Test Site 3, Pile 1

Test Date 12/19/94

Slope Inclinometer Serial Number: 25864

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-18.48	2.43		
1	0	0.0			-16.60	2.27		
1	10	9.9	6.03	6.69	-19.10	2.86	0.59	9.90
1	15	12.4	8.34	8.87	-18.53	2.61	0.34	10.48
1	20	16.9	12.18	12.71	-19.75	2.55	0.28	5.25
1	25	21.9	16.00	16.59	-18.80	2.41	0.14	4.80
1	0	0.3	2.94	2.73	-14.98	1.98	0.29	5.03
3	0	0.2	2.74	2.64	-17.00	2.25	0.02	5.00
3	10	8.2	8.06	8.28	-18.25	2.29	0.02	4.25
3	25	21.9	17.03	17.41	-20.55	2.88	0.61	12.45
10	0	0.1	3.21	3.01	-18.88	2.34	0.07	5.13
10	10	10.7	10.52	10.74	-18.18	2.82	0.55	6.83
10	25	24.6	18.26	18.68	-20.33	3.40	1.13	6.68

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-5.85	6.86		
1	0	0.0			-6.60	6.44		
1	10	9.9	-0.21	-0.15	-6.88	6.55	0.11	20.13
1	15	12.4	-0.13	-0.11	-6.38	7.21	0.77	25.63
1	20	16.9	-0.05	-0.03	-7.13	7.92	1.48	26.13
1	25	21.9	0.00	0.00	-3.68	8.23	1.79	28.33
1	0	0.3	-0.08	-0.07	-4.58	7.41	0.98	23.43
3	0	0.2	-0.07	0.10	-8.13	7.18	0.74	25.88
3	10	8.2	0.06	0.05	-8.15	6.89	0.45	22.15
3	25	21.9	0.03	0.01	-9.50	7.40	0.97	19.50
10	0	0.1	0.46	0.48	-9.10	7.44	1.01	22.90
10	10	10.7	0.38	0.37	-8.20	7.22	0.78	23.80
10	25	24.6	0.32	0.30	-8.30	7.34	0.90	25.30

Summary of Slope Inclinometer Reading Events
Test Site 3, Pile 2

Test Date 12/19/94

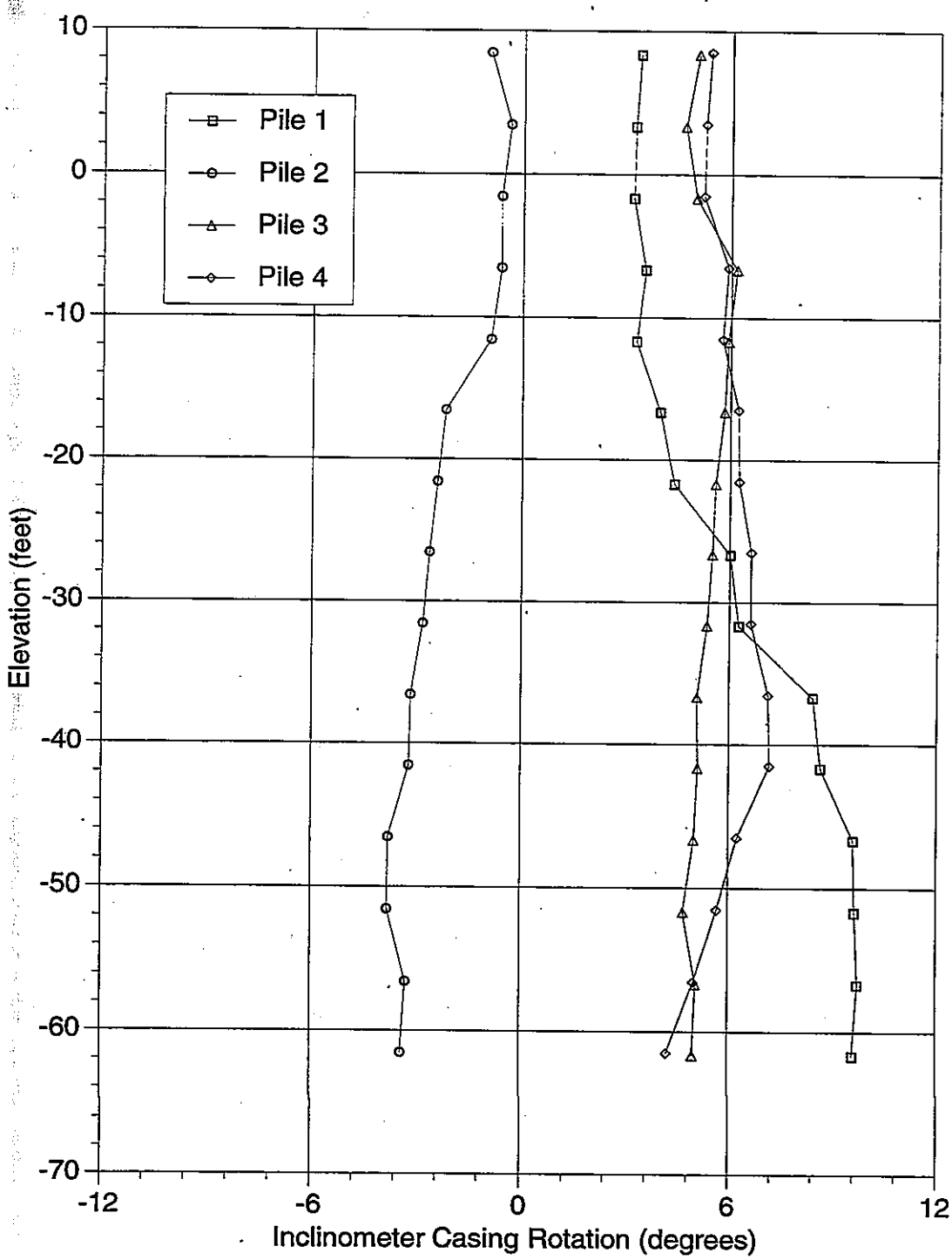
Slope Inclinometer Serial Number: 25690

Measurements in Direction of Applied Lateral Load (A-Direction)

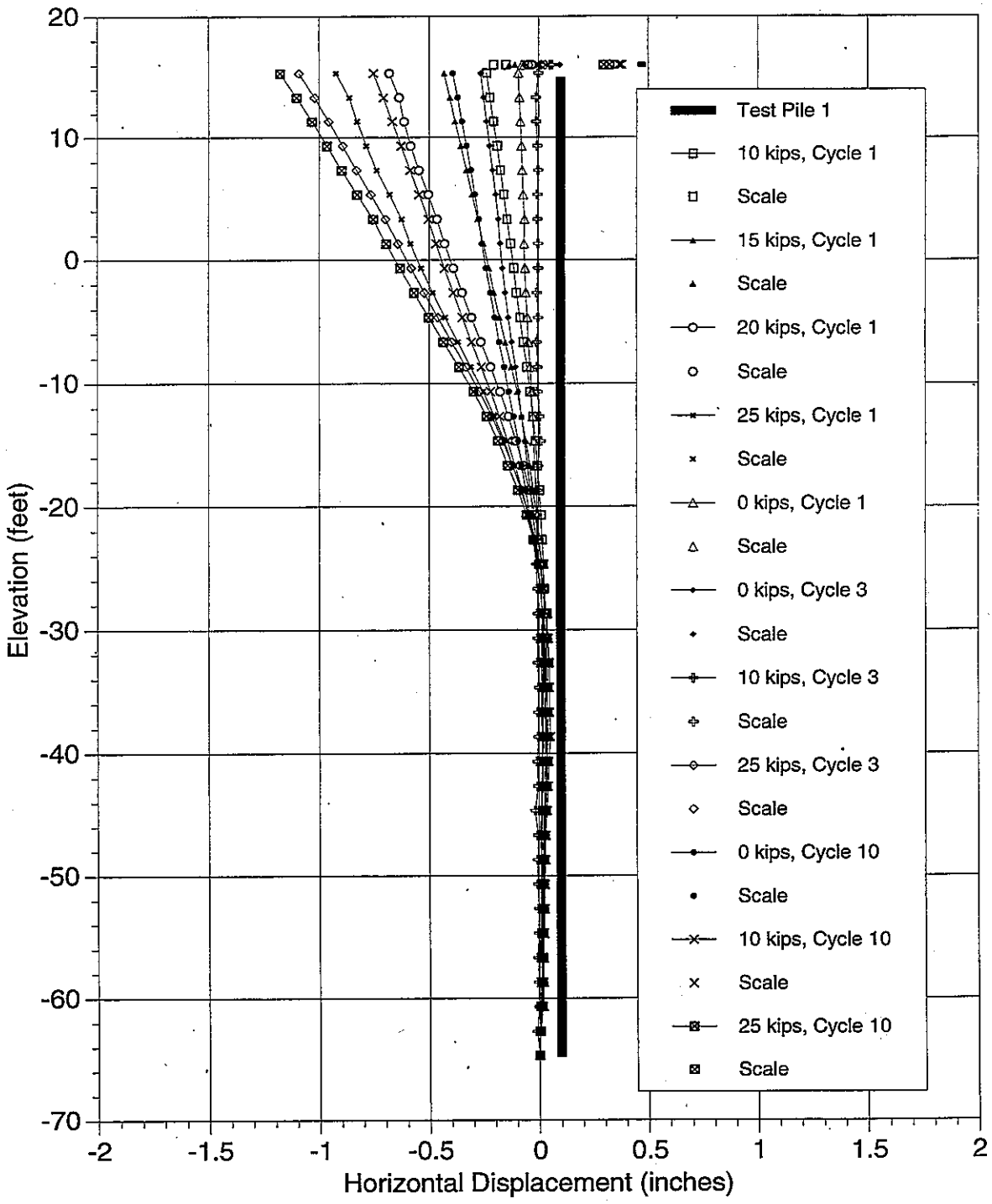
Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-2.36	2.83		
1	0	0.0			-1.90	2.63		
1	10	11.9	5.48	5.86	-3.31	3.41	0.78	8.69
1	15	14.9	7.65	8.31	-3.59	3.71	1.08	9.41
1	20	19.8	11.79	12.40	-3.85	3.57	0.94	6.15
1	25	24.9	15.88	16.43	-5.26	3.41	0.78	9.74
1	0	0.0	2.16	2.04	-1.90	2.58	0.05	8.90
3	0	0.0	2.06	2.03	-3.21	2.52	0.11	9.21
3	10	9.9	7.82	8.02	-2.64	3.27	0.64	10.64
3	25	24.8	17.33	17.71	-4.41	3.16	0.53	7.41
10	0	0.0	2.76	2.62	-2.31	2.86	0.23	10.31
10	10	9.8	10.38	10.53	-3.62	2.53	0.10	6.38
10	25	24.7	18.68	19.13	-6.10	3.68	1.05	7.90

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			39.54	9.33		
1	0	0.0			39.10	9.30		
1	10	11.9	0.23	0.24	38.46	9.43	0.14	23.46
1	15	14.9	0.30	0.31	39.82	8.40	0.90	22.82
1	20	19.8	0.24	0.12	40.69	9.10	0.19	26.69
1	25	24.9	0.23	0.23	41.59	9.57	0.27	27.59
1	0	0.0	0.18	0.16	41.77	8.65	0.65	22.77
3	0	0.0	0.11	0.11	39.51	8.98	0.32	23.51
3	10	9.9	0.08	0.07	41.44	9.63	0.33	23.44
3	25	24.8	0.10	0.11	42.18	9.82	0.53	27.18
10	0	0.0	0.08	0.08	40.74	9.48	0.19	24.74
10	10	9.8	0.01	0.01	38.69	9.76	0.46	25.69
10	25	24.7	0.04	0.06	40.44	9.78	0.48	24.44



Measured Rotation of Slope Inclinometer Casing
Test Site 3



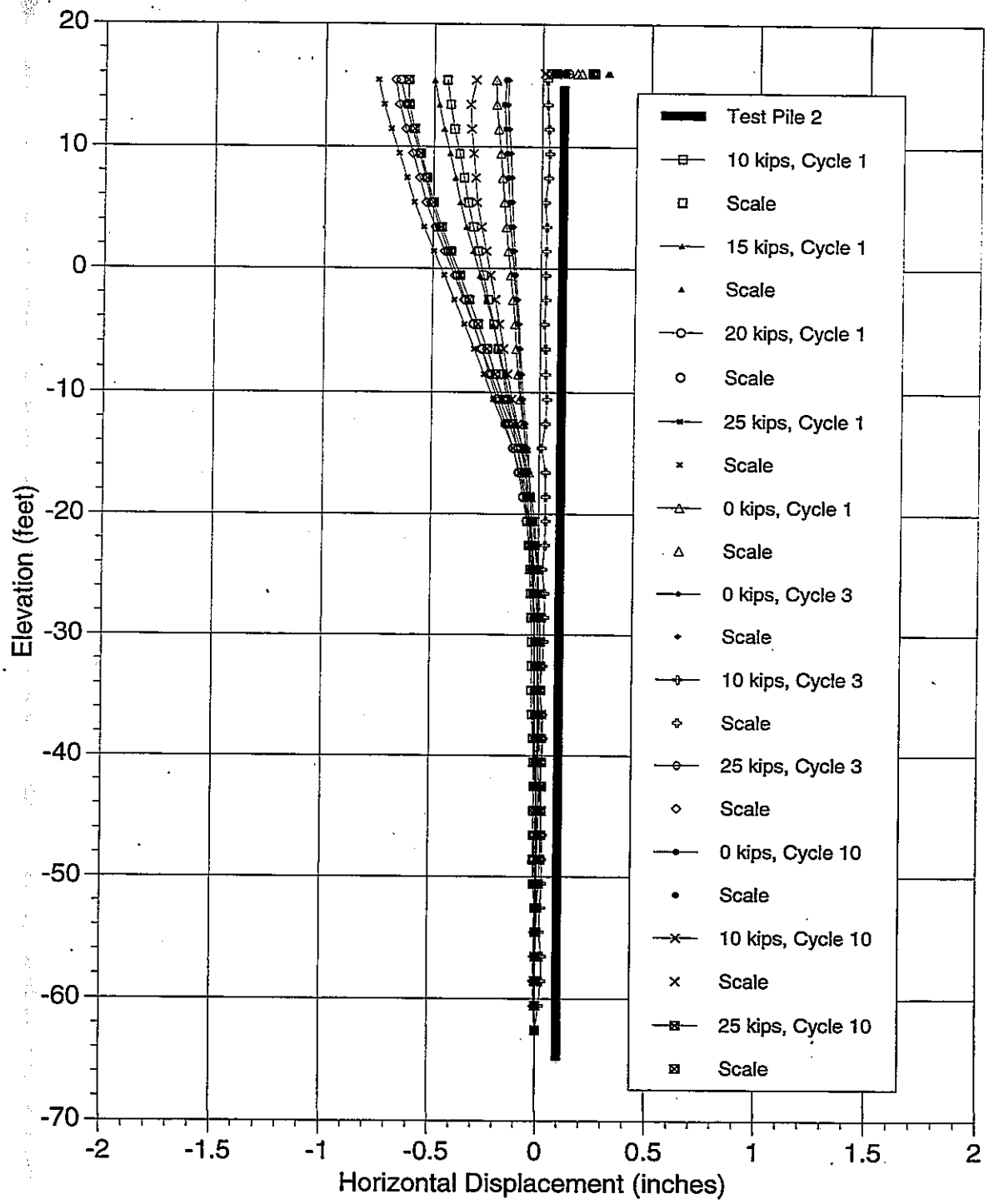
Pile Type: Fundex PP 20x0.5
Grout Volume: 400 gallons
Date Installed: 12/6/94
Date Tested: 12/19/94
Installation Time: 6 hours 13 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -64.8 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -12.8 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 3, Pile 1



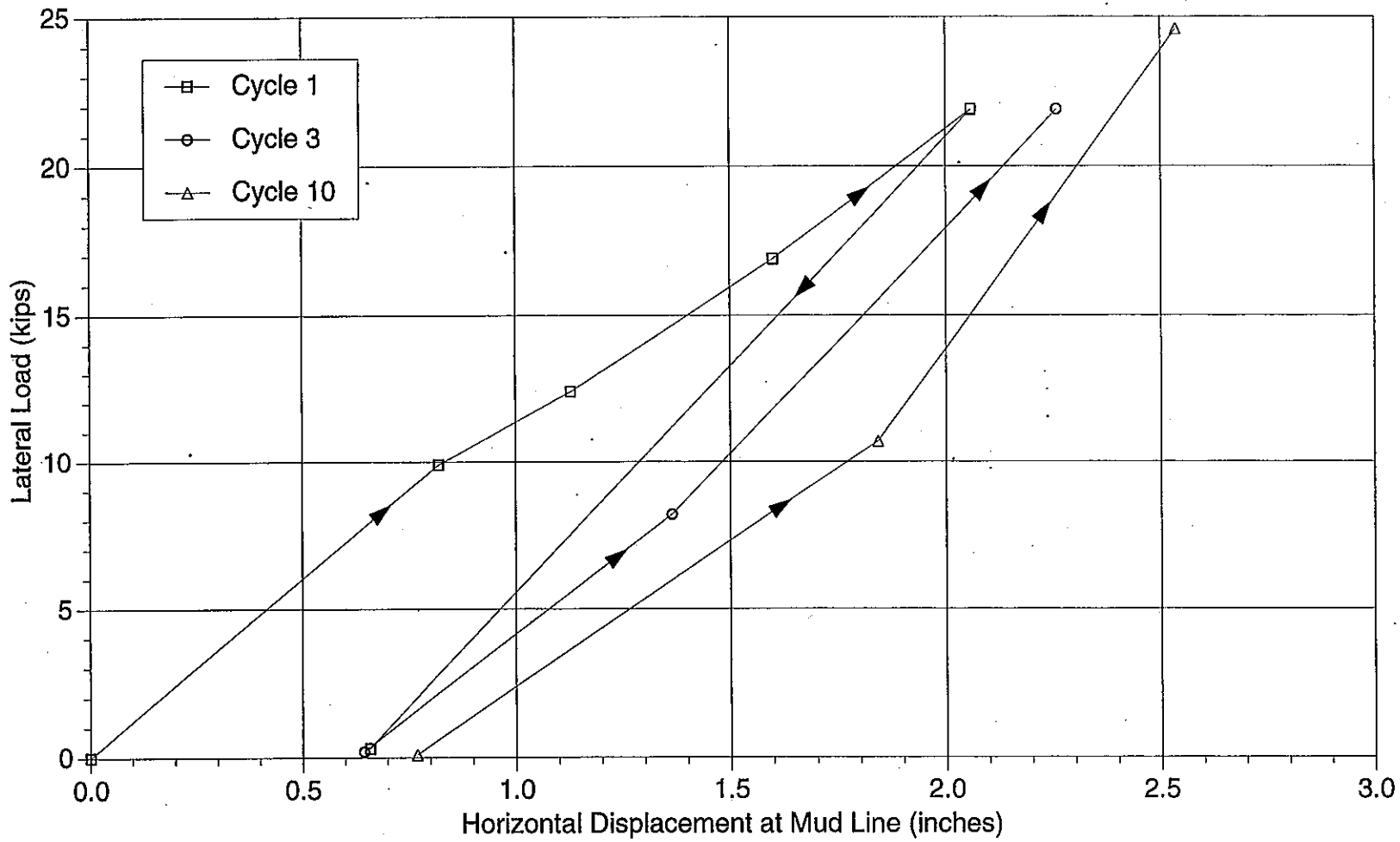
Pile Type: Fundex PP 20x0.5
Grout Volume: 400 gallons
Date Installed: 12/8/94
Date Tested: 12/19/94
Installation Time: 5 hours 54 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -65.0 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -13.6 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 3, Pile 2



Pile Type: Fundex PP 20x0.5

Grout Volume: 400 gallons

Date Installed: 12/6/94

Date Tested: 12/19/94

Installation Time: 6 hours 13 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

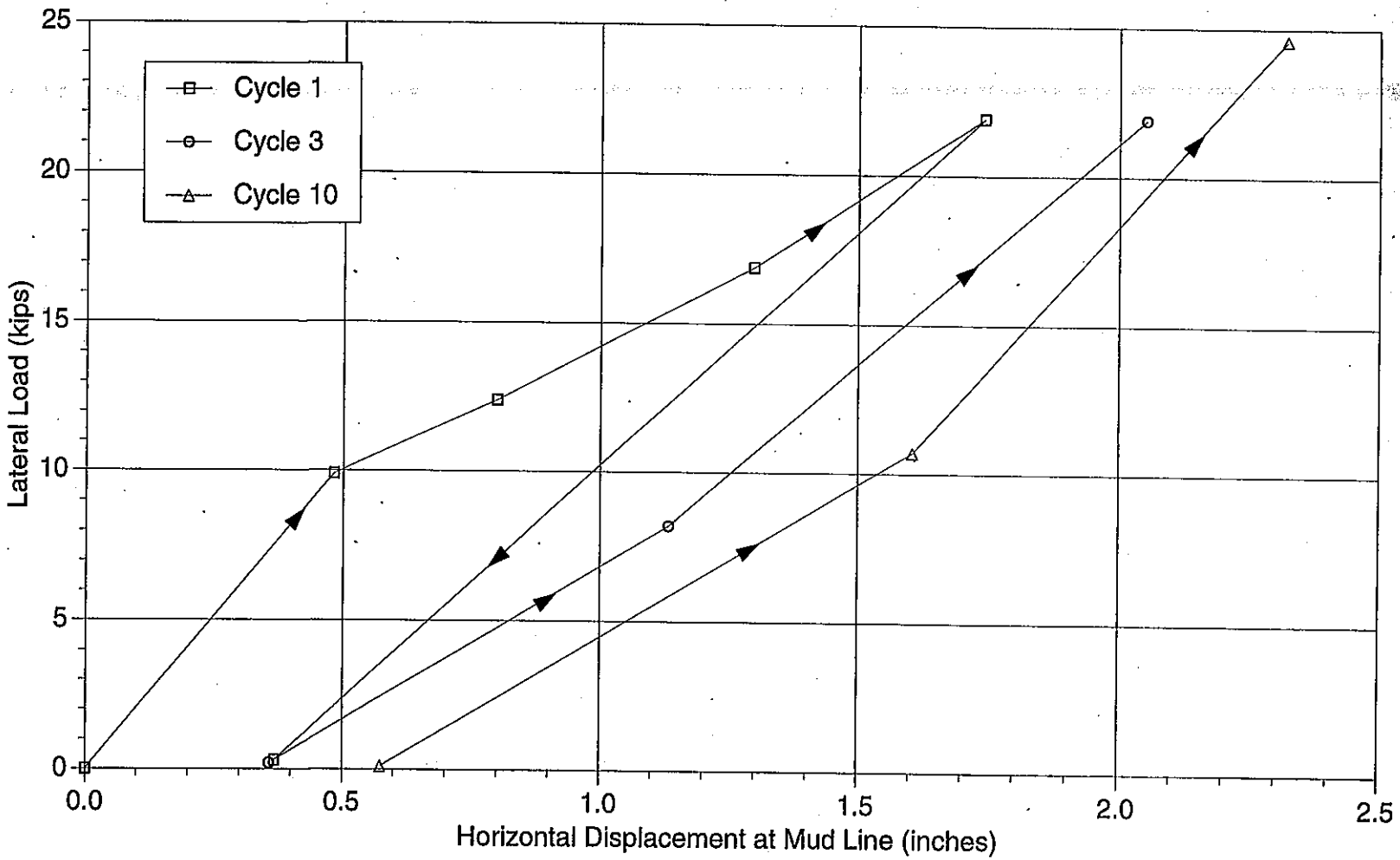
Pile Tip Elevation: -64.8 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -12.8 feet

Lateral Load - Displacement at Mud Line

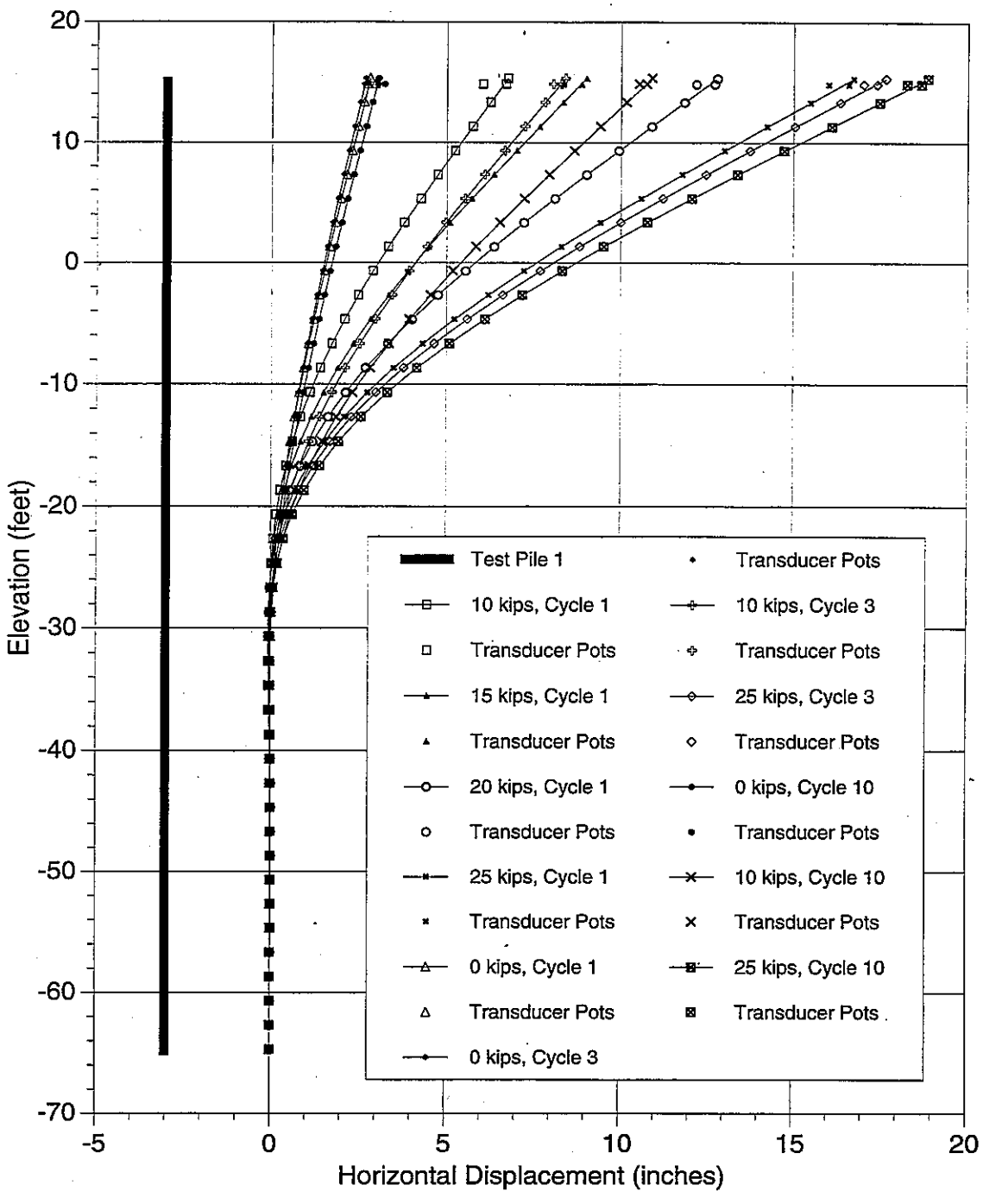
Test Site 3, Pile 1



Pile Type: Fundex PP 20x0.5
Grout Volume: 400 gallons
Date Installed: 12/8/94
Date Tested: 12/19/94
Installation Time: 5 hours 54 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -65.0 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -13.6 feet

Lateral Load - Displacement at Mud Line
Test Site 3, Pile 2



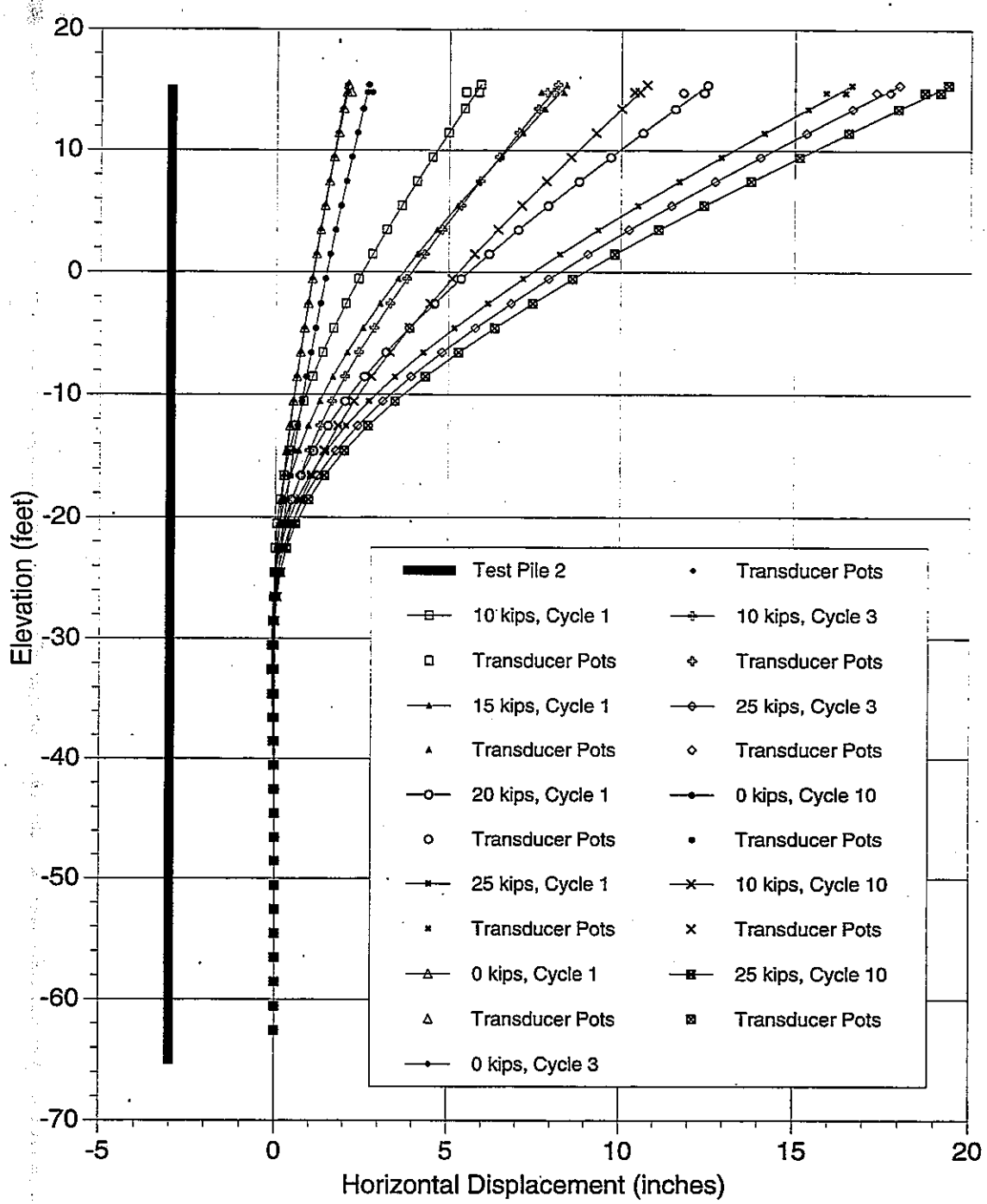
Pile Type: Fundex PP 20x0.5
Grout Volume: 400 gallons
Date Installed: 12/6/94
Date Tested: 12/19/94
Installation Time: 6 hours 13 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -64.8 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -12.8 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 3, Pile 1



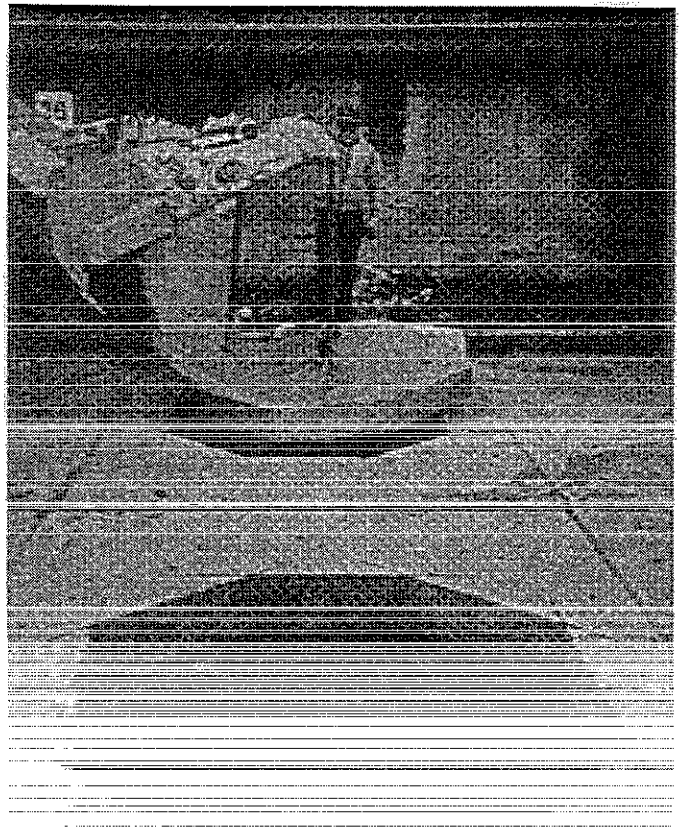
Pile Type: Fundex PP 20x0.5
Grout Volume: 400 gallons
Date Installed: 12/8/94
Date Tested: 12/19/94
Installation Time: 5 hours 54 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -65.0 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -13.6 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 3, Pile 2



INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

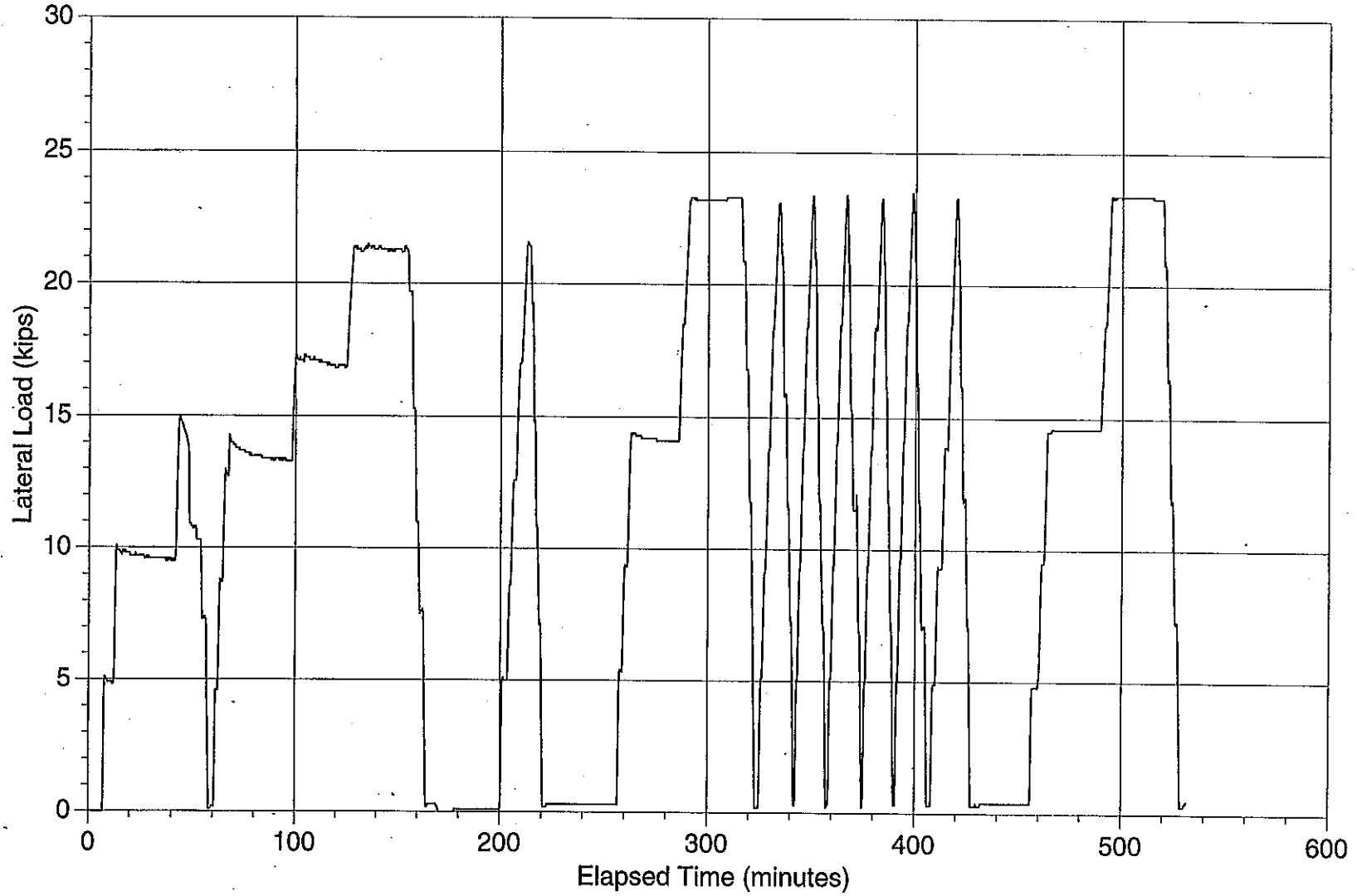
Appendix J

Site 3
Piles 3 and 4
Lateral Load Test Plots

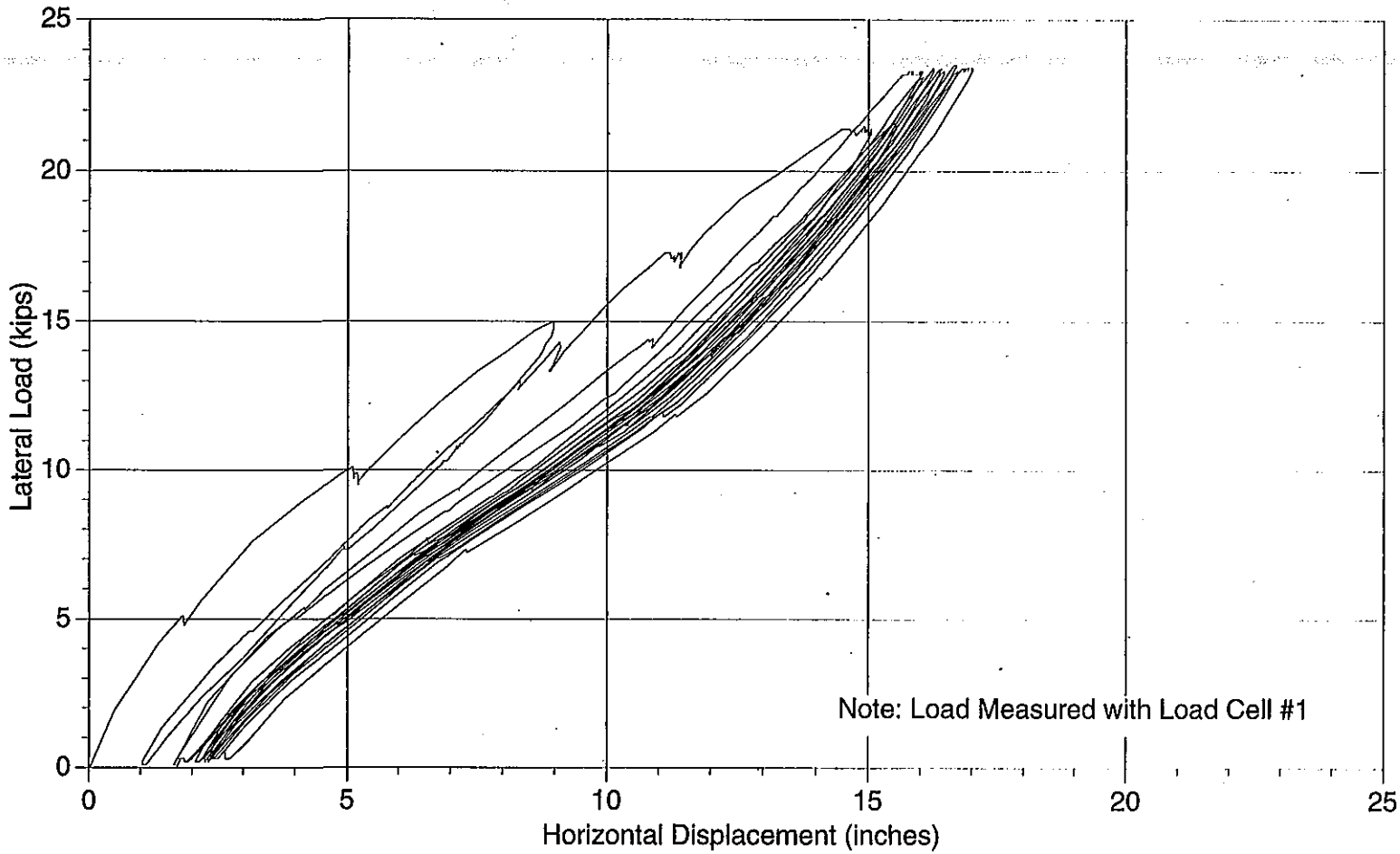
Top: Removal of concrete slab for the 5 foot diameter casings at Site 2.

Bottom: Excavating around the Sample Pile at Site 1

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations
Engineering Service Center
April 1995



Lateral Load - Time History
Test Site 3, Pile 3 and Pile 4



Pile Type: Fundex PP 20x0.5 (-64.5' to -7.5') PP 20x0.75 (-7.5' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/5/94

Date Tested: 12/20/94

Installation Time: 6 hours 58 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

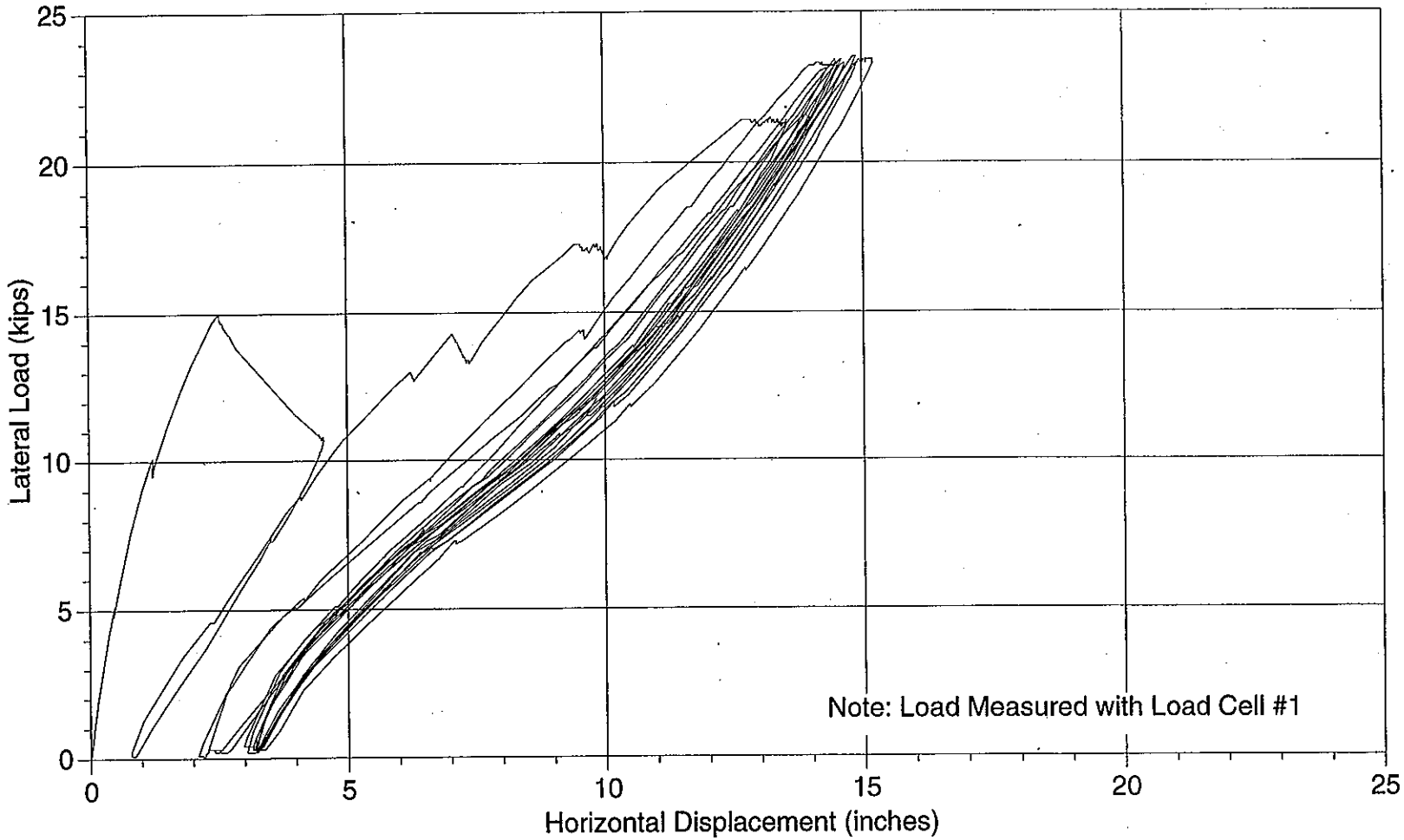
Pile Tip Elevation: -64.5 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.9 feet

Lateral Load - Displacement Near Pile Top

Test Site 3, Pile 3



Pile Type: Fundex PP 20x0.5 (-65' to -8.0') PP 20x0.75 (-8.0' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/9/94

Date Tested: 12/20/94

Installation Time: 7 hours 3 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

Pile Tip Elevation: -65.0 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.0 feet

Lateral Load - Displacement Near Pile Top

Test Site 3, Pile 4

Summary of Slope Inclinometer Reading Events
Test Site 3, Pile 3

Test Date 12/20/94

Slope Inclinometer Serial Number: 27444

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			4.23	3.11		
1	0	0.0			7.26	2.23		
1	10	9.7	4.99	5.21	9.36	2.31	0.09	5.36
1	15	13.5	9.10	8.90	13.08	2.91	0.69	7.08
1	20	17.0	11.12	11.42	17.00	2.87	0.65	8.00
1	25	21.3	14.49	15.04	12.82	2.65	0.42	5.18
1	0	0.1	2.00	1.65	16.69	3.49	1.27	11.31
3	0	0.3	1.96	1.72	9.90	2.20	0.02	4.90
3	15	14.2	10.80	10.86	7.82	2.06	0.17	4.82
3	25	23.2	15.54	16.03	4.82	3.14	0.92	8.82
10	0	0.4	2.50	2.24	1.74	2.64	0.41	6.74
10	15	14.6	12.28	12.53	2.59	1.90	0.32	4.59
10	25	23.4	16.75	16.99	3.64	1.76	0.47	4.36

Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-17.39	6.31		
1	0	0.0			-14.54	6.72		
1	10	9.7	-0.18	-0.22	-10.41	6.89	0.17	22.41
1	15	13.5	-0.30	-0.37	-8.77	6.59	0.13	15.77
1	20	17.0	-0.60	-0.60	-5.56	7.64	0.91	20.56
1	25	21.3	-0.96	-0.86	-6.90	8.16	1.44	28.90
1	0	0.1	-0.22	-0.17	-5.85	6.22	0.50	21.85
3	0	0.3	-0.17	-0.17	-13.31	6.45	0.27	18.31
3	15	14.2	-0.36	-0.37	-13.23	6.99	0.26	17.23
3	25	23.2	-0.67	-0.73	-15.08	7.79	1.07	29.08
10	0	0.4	-0.22	-0.22	-18.33	6.02	0.70	13.33
10	15	14.6	-0.46	-0.46	-15.15	7.16	0.43	18.15
10	25	23.4	-0.65	-0.70	-15.72	6.92	0.20	18.72

Summary of Slope Inclinometer Reading Events
Test Site 3, Pile 4

Test Date 12/20/94

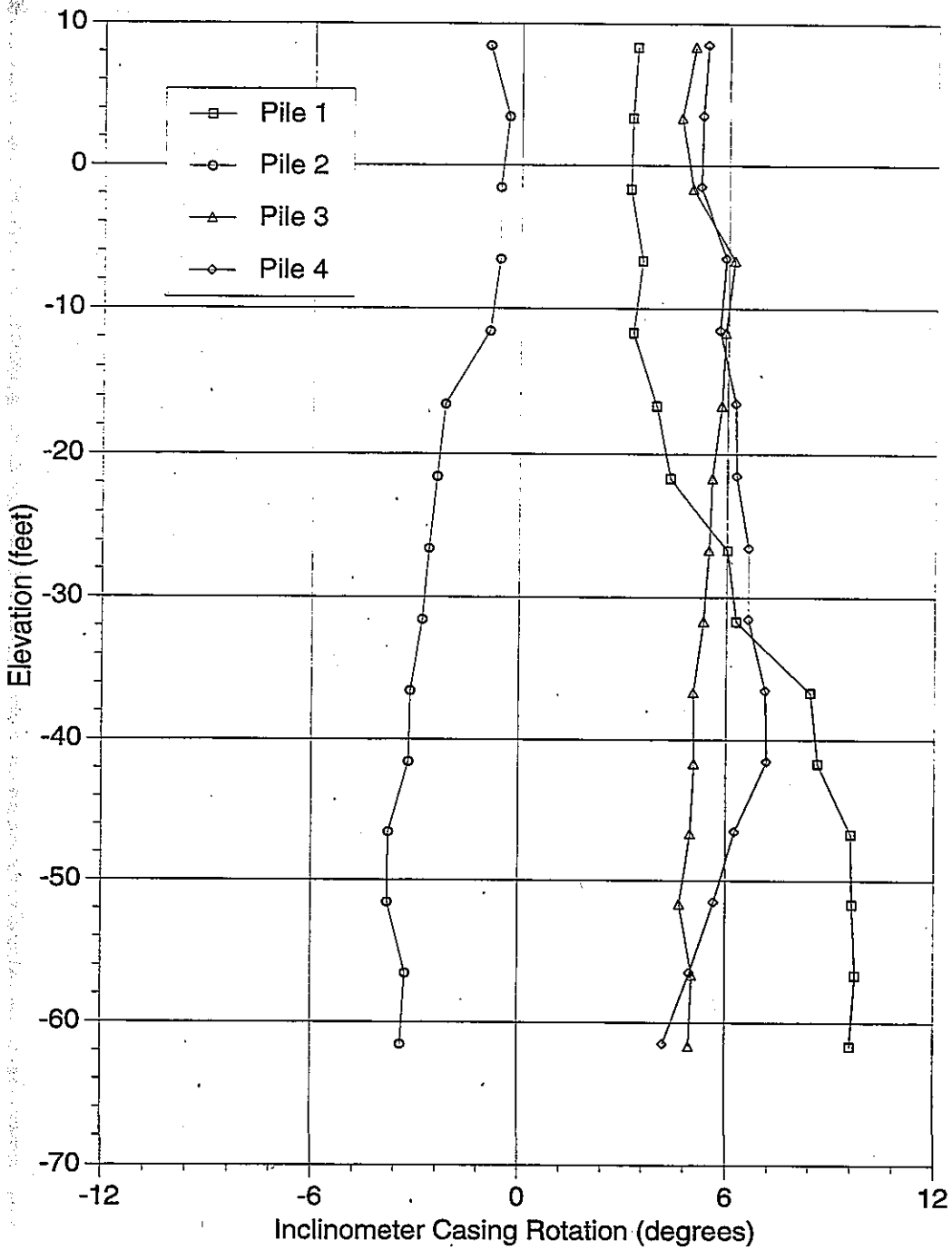
Slope Inclinometer Serial Number: 25690

Measurements in Direction of Applied Lateral Load (A-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			-1.69	4.40		
1	0	0.0			-0.18	4.63		
1	10	10.6	1.21	1.24	-1.62	4.47	0.16	13.38
1	15	15.5	7.11	7.37	-3.15	5.46	0.83	16.15
1	20	19.8	9.42	10.07	-2.64	5.52	0.89	17.64
1	25	24.9	12.68	13.54	-4.38	6.75	2.12	18.38
1	0	0.0	2.55	2.09	0.15	4.59	0.04	15.15
3	0	0.0	2.73	2.29	0.23	4.93	0.30	16.23
3	15	13.7	9.50	9.61	-1.21	5.48	0.85	16.21
3	25	25.0	13.86	14.54	-2.26	7.20	2.57	21.26
10	0	0.0	3.30	2.98	-0.31	5.73	1.10	16.69
10	15	15.5	10.98	11.23	-3.44	5.52	0.89	16.44
10	25	25.0	14.89	15.22	-3.64	5.54	0.91	15.64

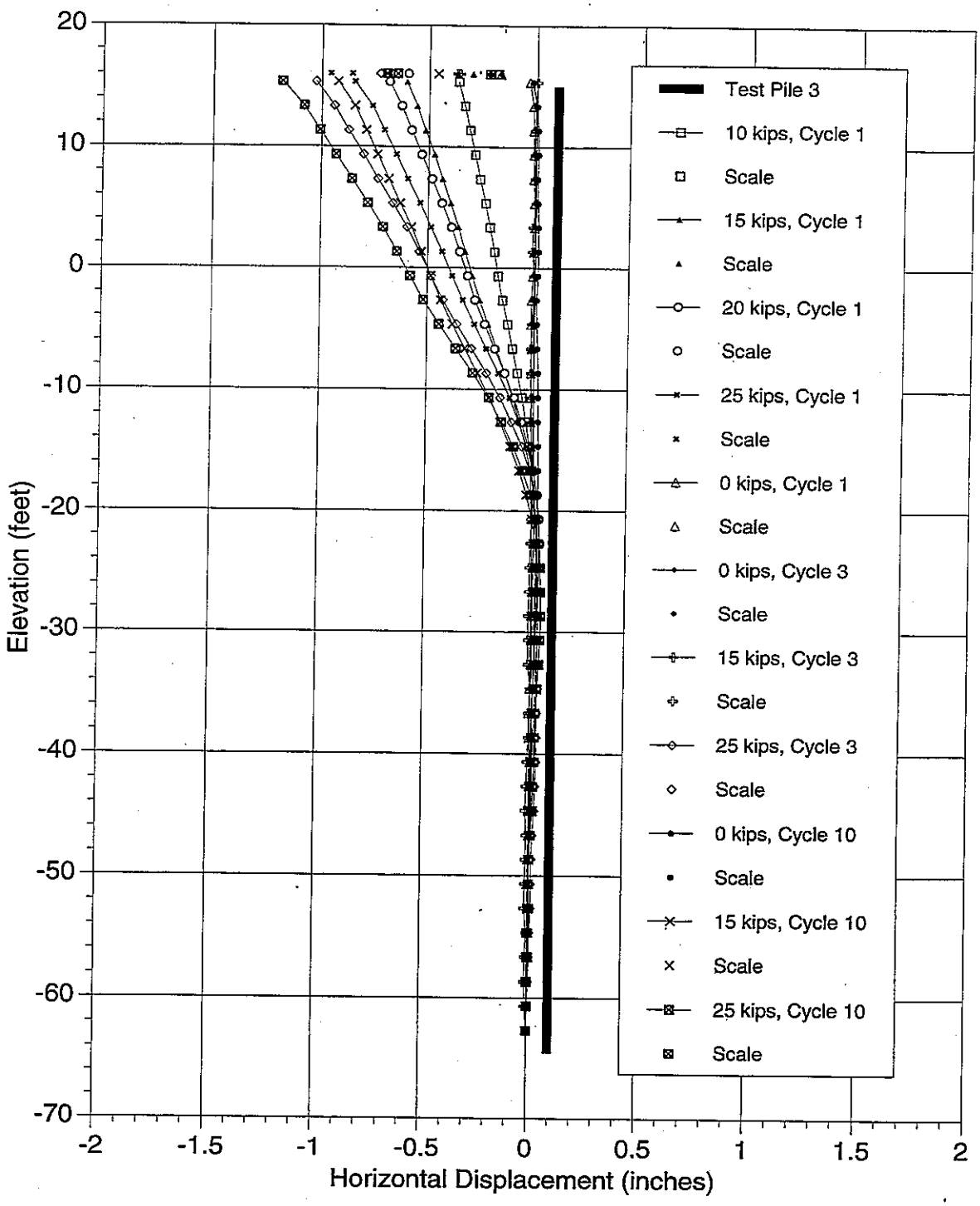
Measurements in Direction Transverse to Applied Lateral Load (B-Direction)

Cycle Number	Nominal Lateral Load (kips)	Average Measured Lateral Load (kips)	Measured Displacement Near Pile Top (inches) Begin Cycle	End Cycle	Mean Checksum (MCS)	Standard Deviation Checksum (SDC)	Standard Deviation Difference (SDD)	Maximum Checksum Variance (MCV)
1	0	0.0			35.82	11.27		
1	0	0.0			36.90	11.86		
1	10	10.6	0.04	0.04	38.00	11.93	0.07	27.00
1	15	15.5	-0.13	-0.16	39.59	11.53	0.33	22.59
1	20	19.8	-0.19	-0.19	40.64	11.67	0.19	26.64
1	25	24.9	-0.31	-0.32	40.33	11.82	0.05	24.33
1	0	0.0	-0.15	-0.22	38.67	11.39	0.47	26.67
3	0	0.0		0.01	38.62	11.53	0.33	24.62
3	15	13.7	-0.26	-0.26	42.59	10.47	1.39	23.59
3	25	25.0	-0.50	-0.51	42.28	10.70	1.17	26.28
10	0	0.0	0.05	0.05	37.33	11.11	0.75	21.33
10	15	15.5	-0.31	-0.31	38.79	11.45	0.41	29.79
10	25	25.0	-0.52	-0.52	38.82	11.73	0.13	25.82



Measured Rotation of Slope Inclinometer Casing

Test Site 3



Pile Type: Fundex PP 20x0.5 (-64.5' to -7.5') PP 20x0.75 (-7.5' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/5/94

Date Tested: 12/20/94

Installation Time: 6 hours 58 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

Pile Tip Elevation: -64.5 feet

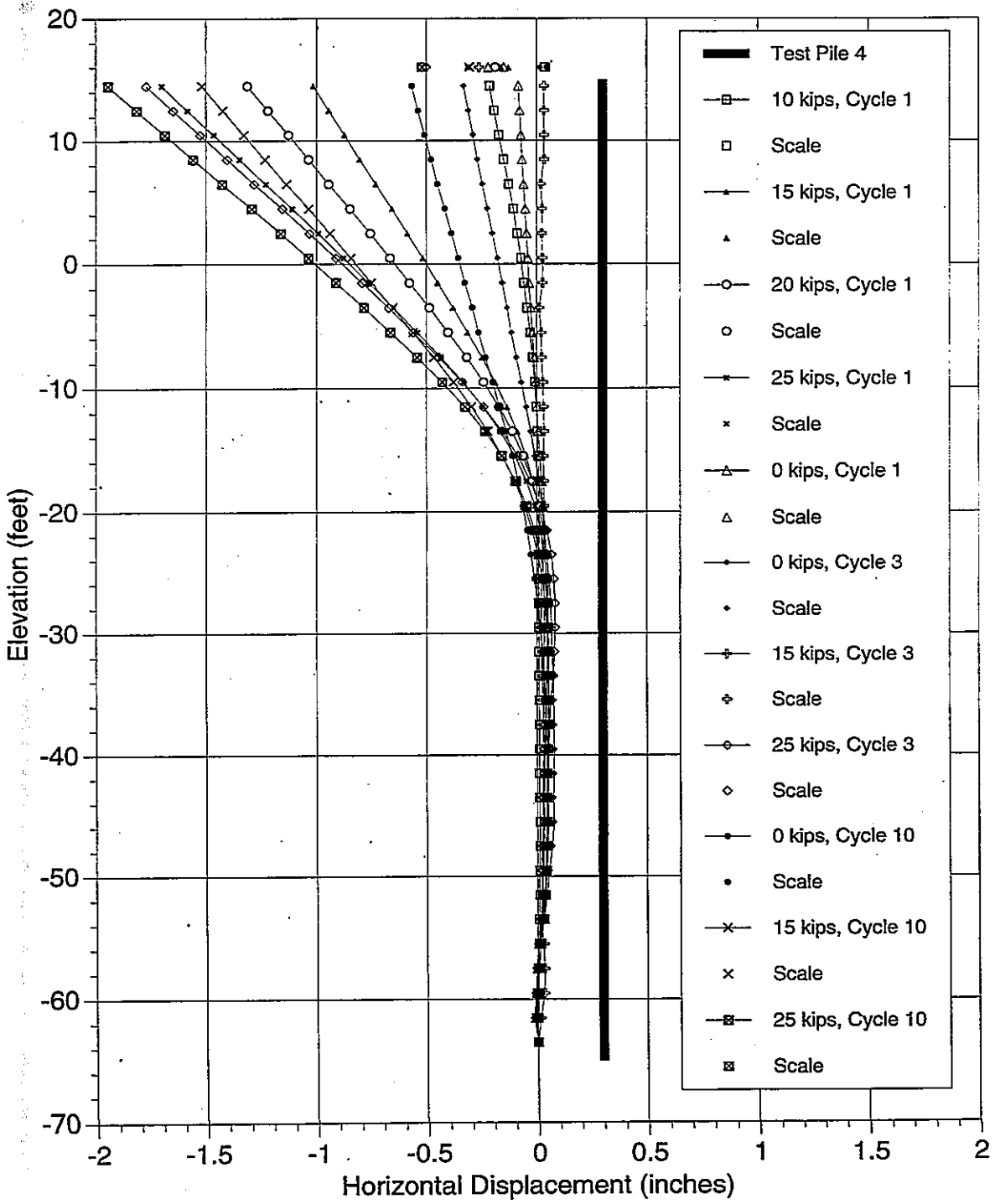
Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.9 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 3, Pile 3



Pile Type: Fundex PP 20x0.5 (-65' to -8.0') PP 20x0.75 (-8.0' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/9/94

Date Tested: 12/20/94

Installation Time: 7 hours 3 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

Pile Tip Elevation: -65.0 feet

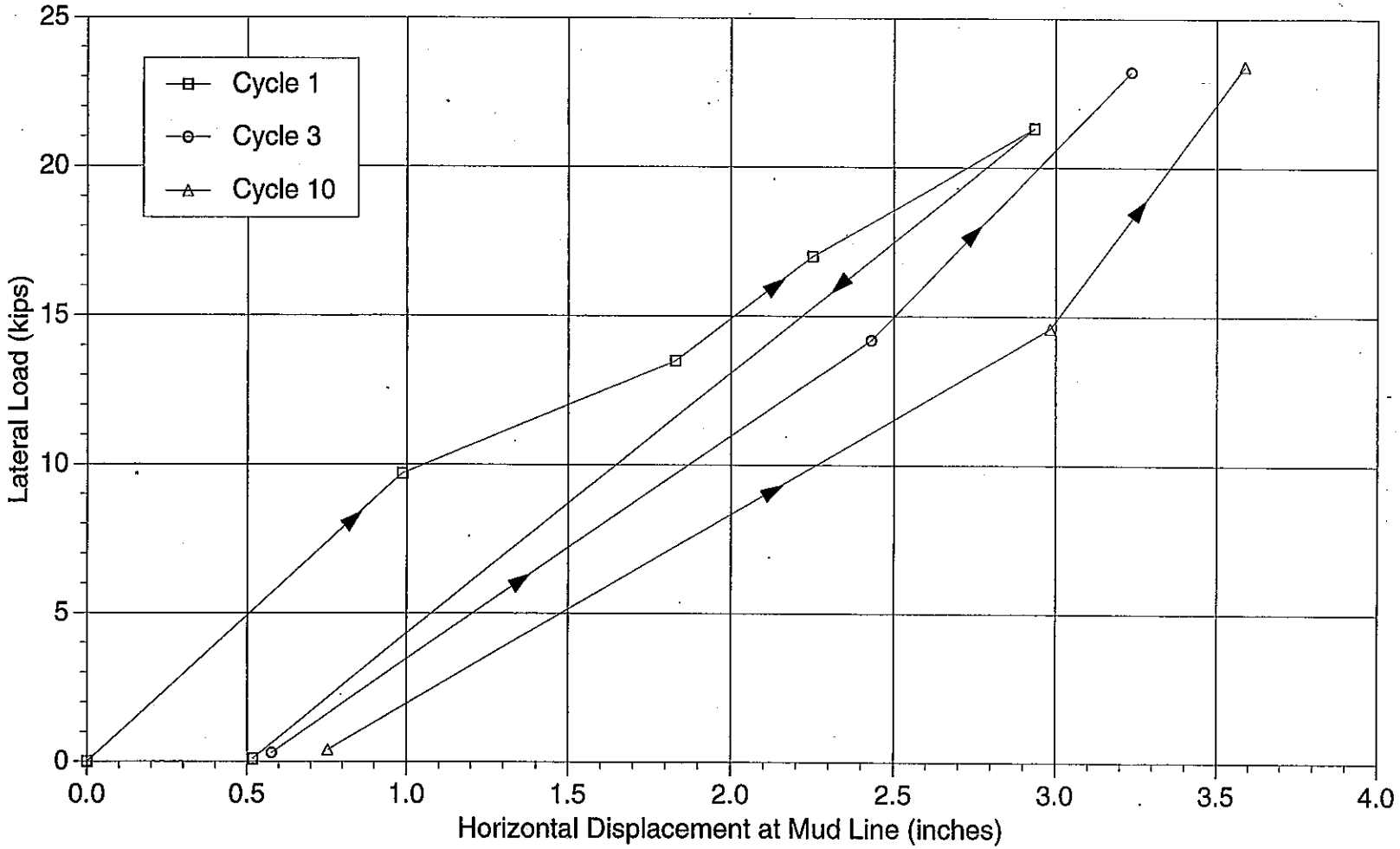
Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.0 feet

Slope Inclinometer and Surface Displacement Measurements

Direction Transverse to Applied Lateral Load

Test Site 3, Pile 4



Pile Type: Fundex PP 20x0.5 (-64.5' to -7.5') PP 20x0.75 (-7.5' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/5/94

Date Tested: 12/20/94

Installation Time: 6 hours 58 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

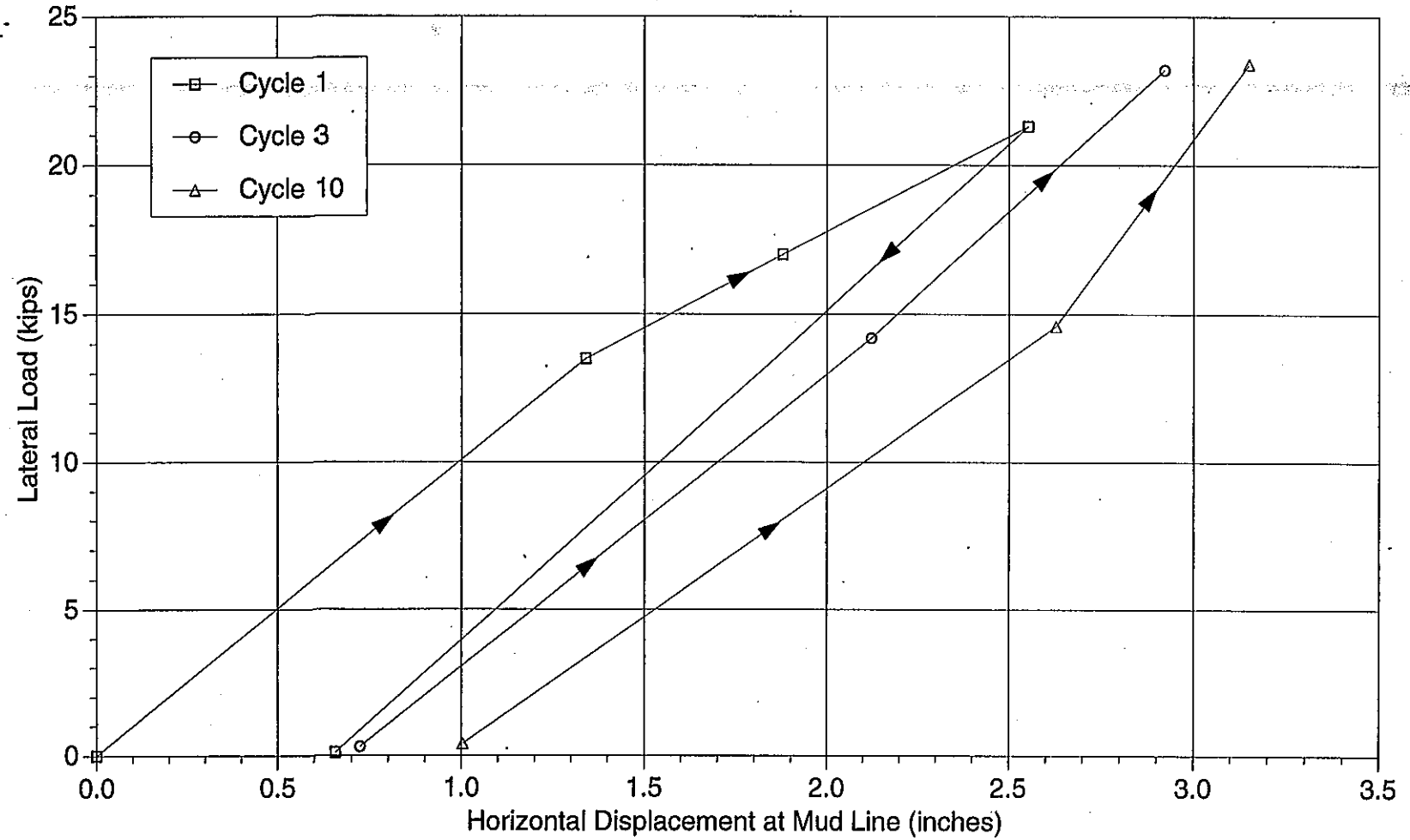
Pile Tip Elevation: -64.5 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.9 feet

Lateral Load - Displacement at Mud Line

Test Site 3, Pile 3



Pile Type: Fundex PP 20x0.5 (-65' to -8.0') PP 20x0.75 (-8.0' to 15.0')

Grout Volume: 320 gallons

Date Installed: 12/9/94

Date Tested: 12/20/94

Installation Time: 7 hours 3 minutes

Ground Surface Elevation: 12.0 feet

Pile Top Elevation: 15.0 feet

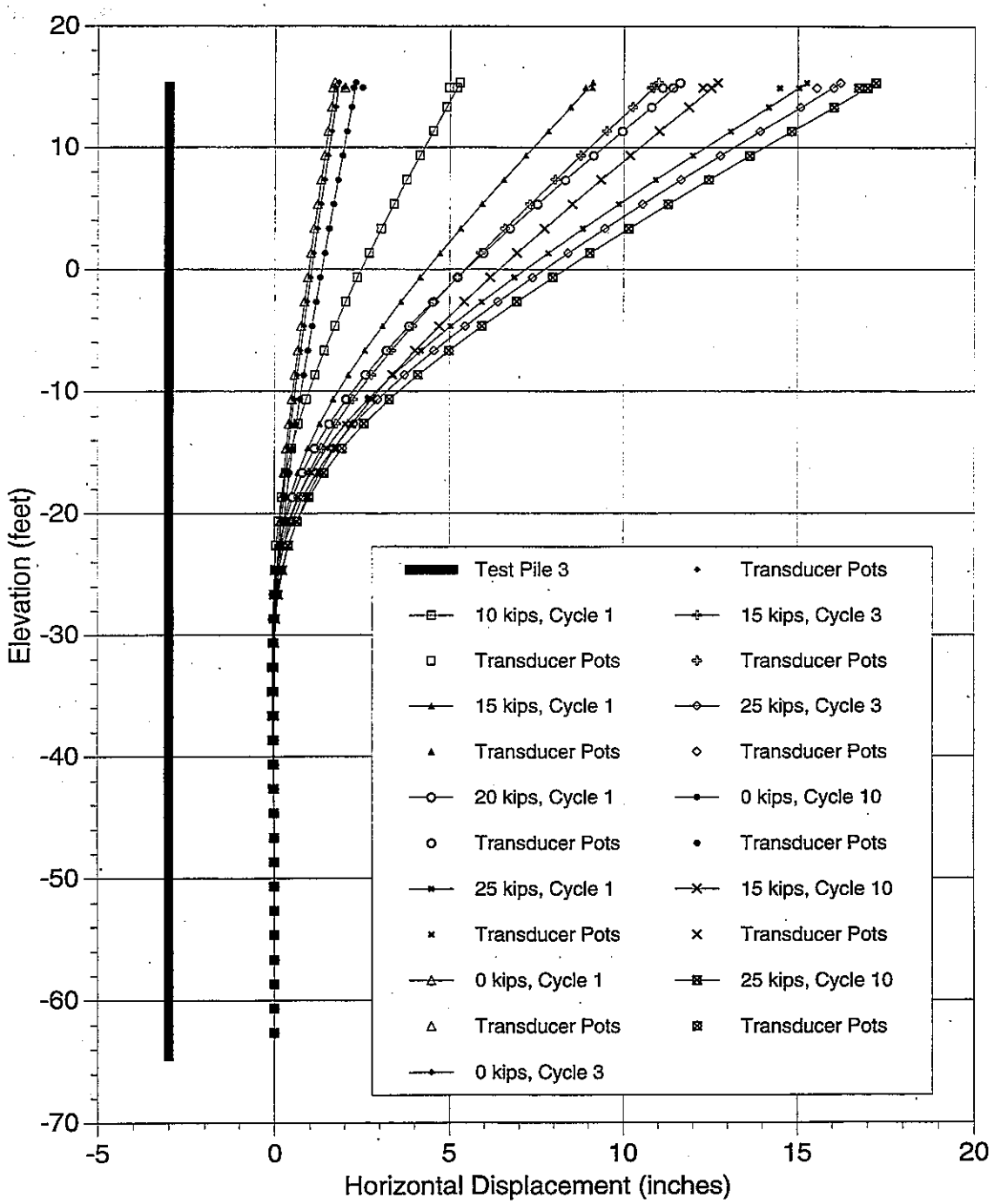
Pile Tip Elevation: -65.0 feet

Bottom of Casing Elevation: -15.0 feet

Top of Mud Line Elevation: -9.0 feet

Lateral Load - Displacement at Mud Line

Test Site 3, Pile 4

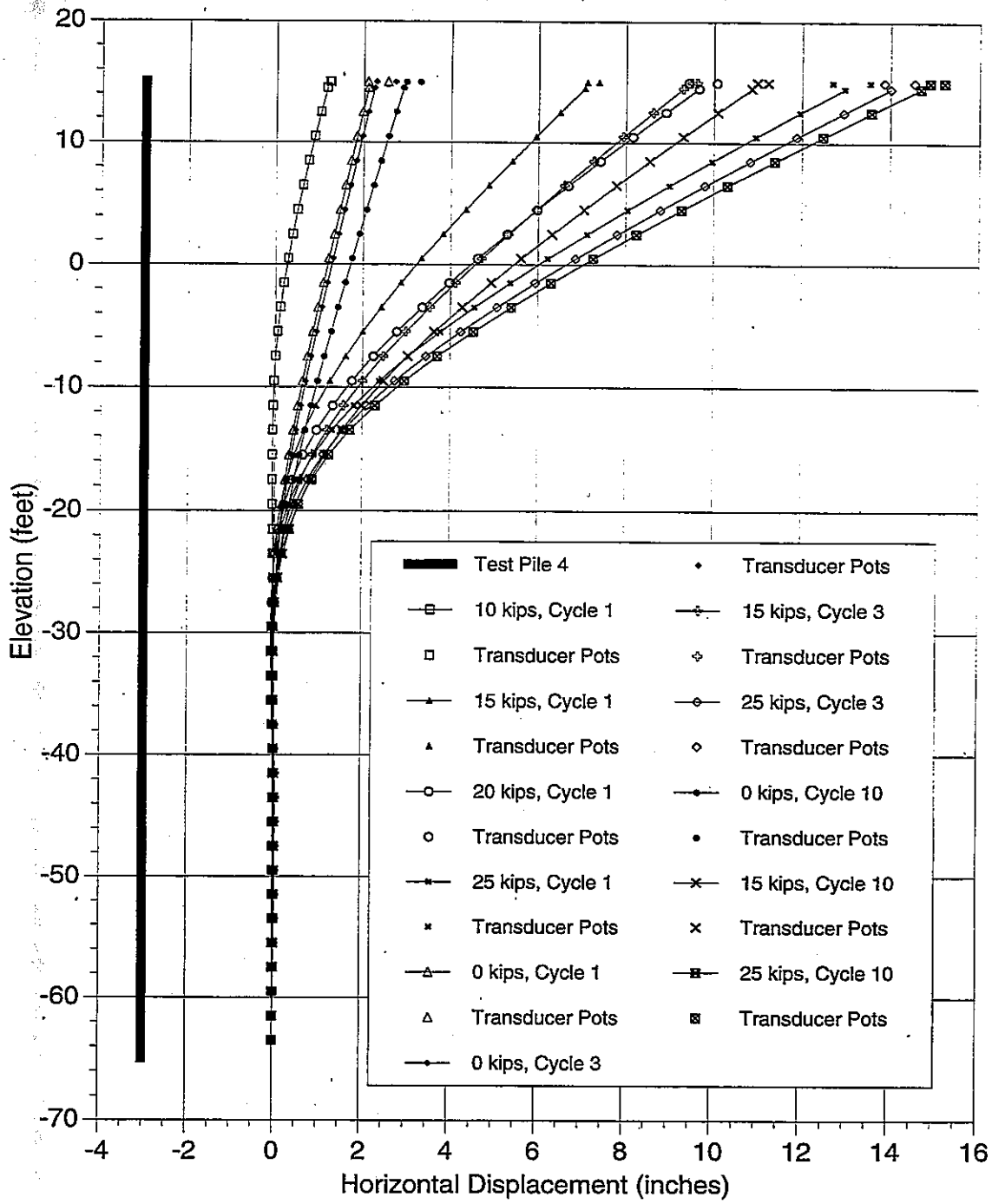


Pile Type: Fundex PP 20x0.5 (-64.5' to -7.5') PP 20x0.75 (-7.5' to 15.0')
Grout Volume: 320 gallons
Date Installed: 12/5/94
Date Tested: 12/20/94
Installation Time: 6 hours 58 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -64.5 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -9.9 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load
Test Site 3, Pile 3



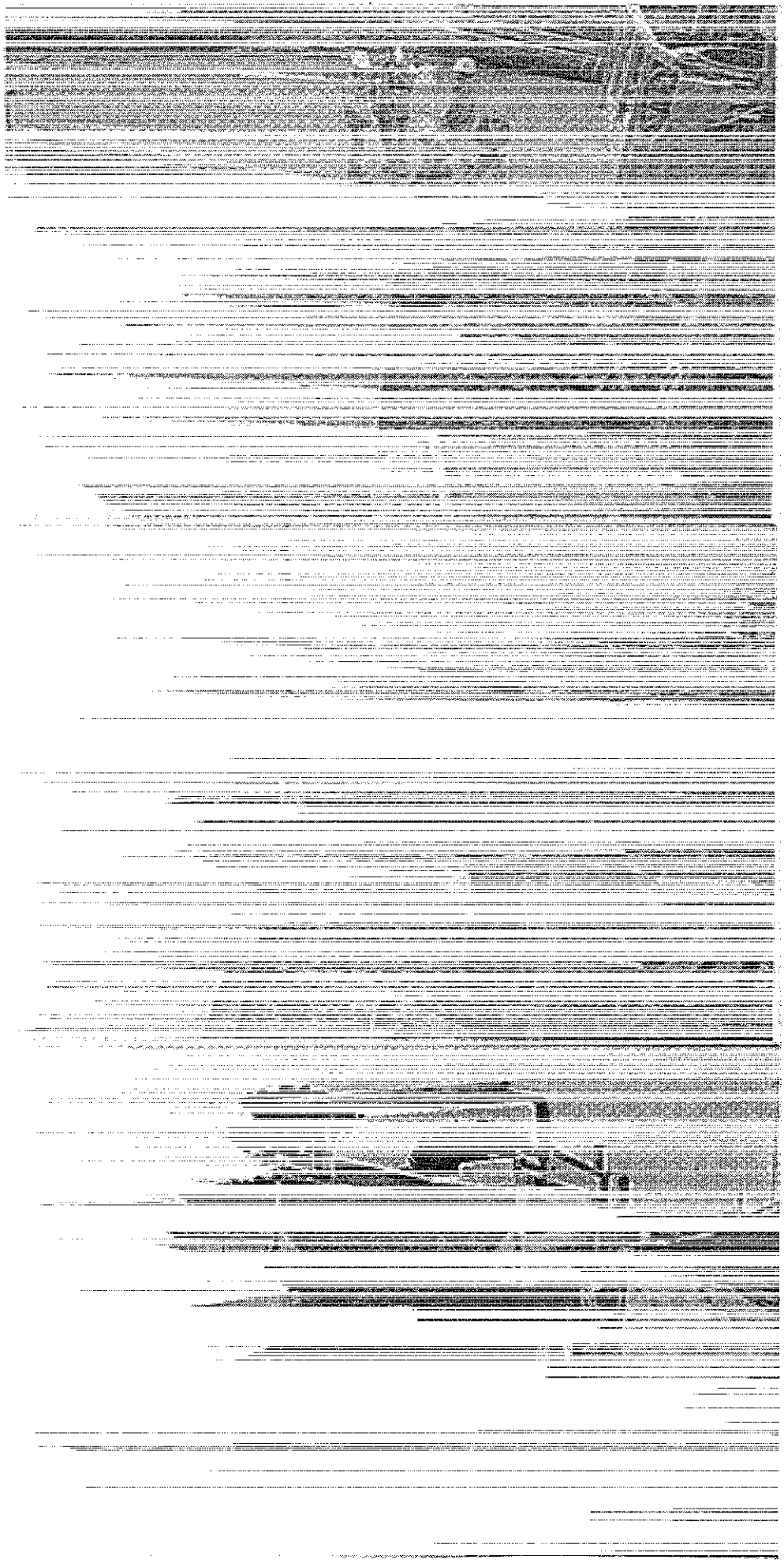
Pile Type: Fundex PP 20x0.5 (-65' to -8.0') PP 20x0.75 (-8.0' to 15.0')
Grout Volume: 320 gallons
Date Installed: 12/9/94
Date Tested: 12/20/94
Installation Time: 7 hours 3 minutes

Ground Surface Elevation: 12.0 feet
Pile Top Elevation: 15.0 feet
Pile Tip Elevation: -65.0 feet
Bottom of Casing Elevation: -15.0 feet
Top of Mud Line Elevation: -9.0 feet

Slope Inclinometer and Surface Displacement Measurements

Direction of Applied Lateral Load

Test Site 3, Pile 4



INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494

Appendix K

Site 1 Pile 6 Pile Driving Analyzer Information

Top: Preparing first pile section for a pile at Site 1.

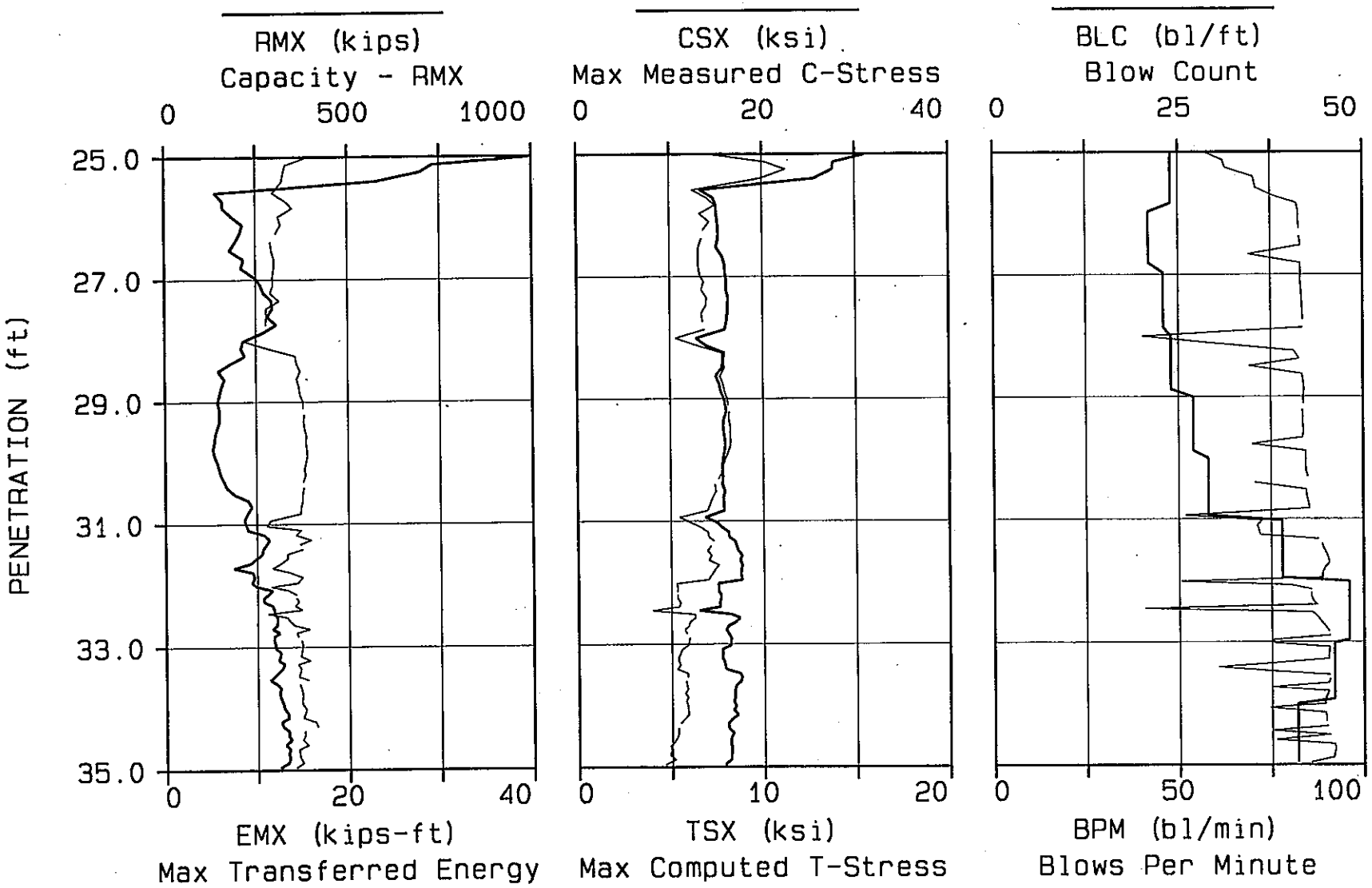
Middle: Preparing the second section for a pile at Site 1. Note Bay in Background.

Bottom: End dumping pea gravel between the piles and the casings at Site 3.

Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995

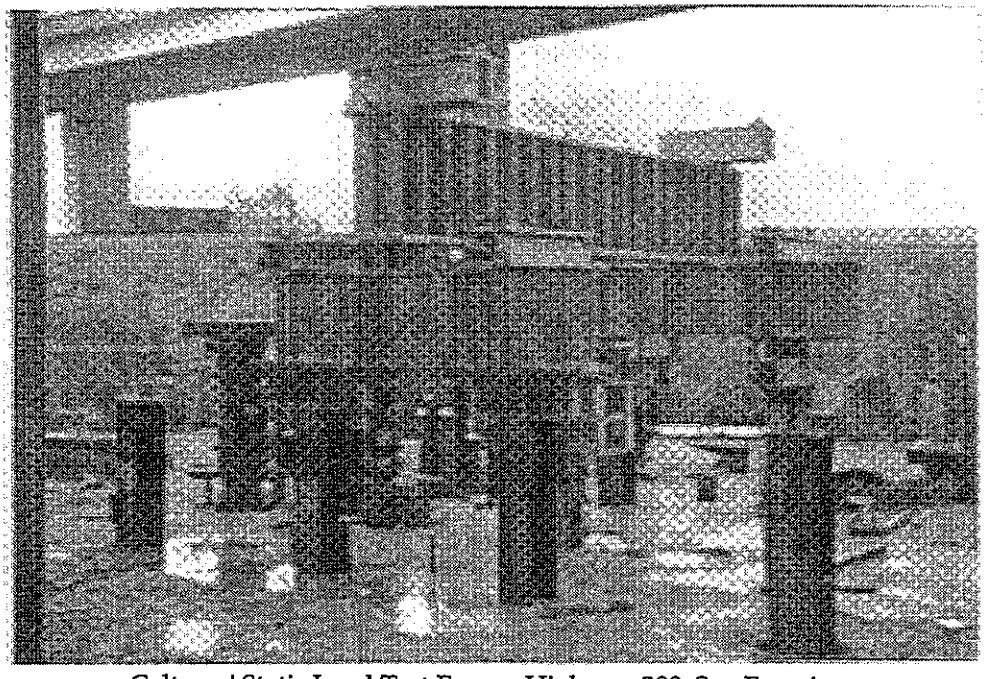
California D.O.T. 94/12/22

SFOBB IPTP SITE 1, P6, PP24X0.5 OPEN END



INDICATOR PILE TEST PROGRAM FOR THE SEISMIC RETROFIT OF THE EAST APPROACH STRUCTURE OF THE SAN FRANCISCO - OAKLAND BAY BRIDGE OAKLAND, CALIFORNIA

CONTRACT NO. 04-043494



Caltrans' Static Load Test Frame, Highway 280, San Francisco

Appendix L

Sample Pile 4-Point Load Test and Analysis of Test Results

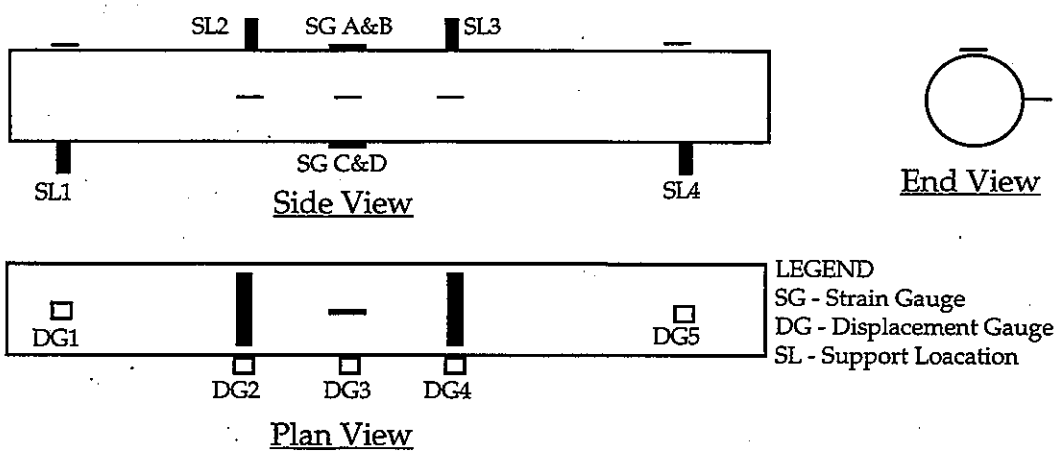
Report Written By
Foundation Testing and Instrumentation
Office of Structural Foundations, Engineering Service Center
April 1995

Sample Pile 4-Point Load Test and Analysis of Test Results

To assess the relationship between pile bending, stiffness and moment, a full scale test was performed in the laboratory on a segment of the concrete filled pipe pile This pile segment was loaded by 4-point loading as shown in the "Pile Loading Diagram". Load applied ato the pile and strains at the center span were recorded to assess the bending stiffness-moment relationship. This relationship was then compared to the relationship predicted by a computer model.

For this test two strain gauges were mounted at the center span and on the top surface of the pile. Two additional strain gauges were mounted at the center span and on the bottom surface of the pile. Five displacement gauges were used to measure displacement, see the "Instrumentation Diagram" below.

Instrumentation Diagram



On February 21, 1995, a 4.3 m (14 ft) length of concrete filled pipe was loaded into a press for a 4-point load test (see Photographs and Pile Load Diagram in this Appendix). The pile was loaded in 111 kN (25 kip) increments and each load was held for 1 minute. A seating load of 5 kips was needed to keep the press and the pile in alignment, therefore, after the maximum load of 275 kips was achieved on the first cycle, the pile was unloaded to 5 kips (see Load verses Time History, in this Appendix). The maximum load achieved during subsequent cycles was increased by 50 kips per cycle, through the sixth cycle which had a maximum load of 525 kips. In the third to last cycle, the pile was loaded to 700 kips. Two days later, the pile was loaded to 775 kips (cycle 8) on the second to last cycle. The pile was then loaded to a maximum load of 500 kips on the final cycle.

Strain readings from strain gauges A and B were compared and averaged to determine the strain at the outer most fiber. Strain readings from gauges C and D were likewise compared and averaged. This strain gauge information was then used to determine the location of the neutral axis (see plot of Neutral Axis verses Moment), and the bending stiffness (see plot of Pile Bending Stiffness verses Moment) determined from strain gauge data. In these plots, strain gauge data was baselined at the beginning of each cycle. Also

contained on the plot of Pile Bending Stiffness verses Moment determined from strain gauge data is a stiffness verses moment relationship calculated through the use of the COM624P program.

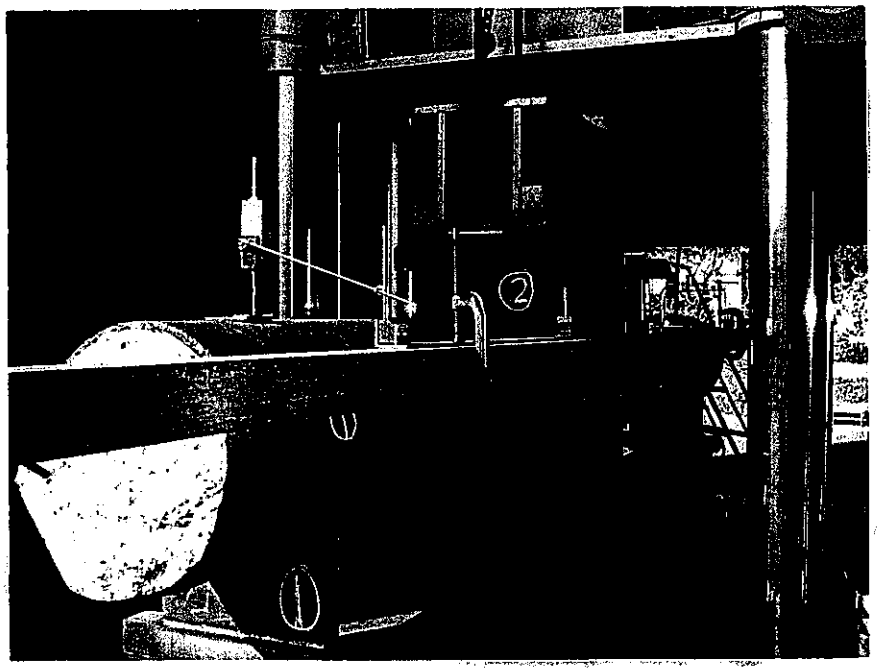
The pile was placed in the press in the position indicated in the instrumentation diagram, but instead of the top of the press moving down to apply load to the top two supports, the bottom of the press moves up to apply load the two bottom supports, and the top two supports are fixed. This has the effect of causing the outer two displacement gauges to have the largest displacement, and the center displacement gauge to have the smallest displacement. This required that the displacement readings for gauge 1 and 5 to be "normalized" to zero, and a correction factor applied to the other three gauges. This, in effect, fixed the outer two lower supports so that they have no displacement. The slope of the load-displacement plot for the displacement gauge at the center of the pile was then used to develop the Pile Bending Stiffness verses Moment relationship from strain gauge data only. As can be seen, this plot is somewhat more erratic than that determined from the strain gauge data.

The two plots of Pile Bending Stiffness verses Moment compare favorably. The plot determined from the strain data has a stiffness in the flat portion of the curve of approximately 65,000,000 kip-sqin, while the plot determined from the displacement data has a stiffness in the flat portion of the curve of a little less than 60,000,000 kip-sqin. The plot of the stiffness for the COM624P run , however, is lower with a stiffness of 50,000,000 kip-sqin for the flat portion of the curve .

Further refinement of input parameters for the COM624P program failed to provide a significantly better match to the measured data. This leads to the conclusion that COM624P is a very simplified model of a complicated system, and that as such, tends to predict stiffness conservatively.

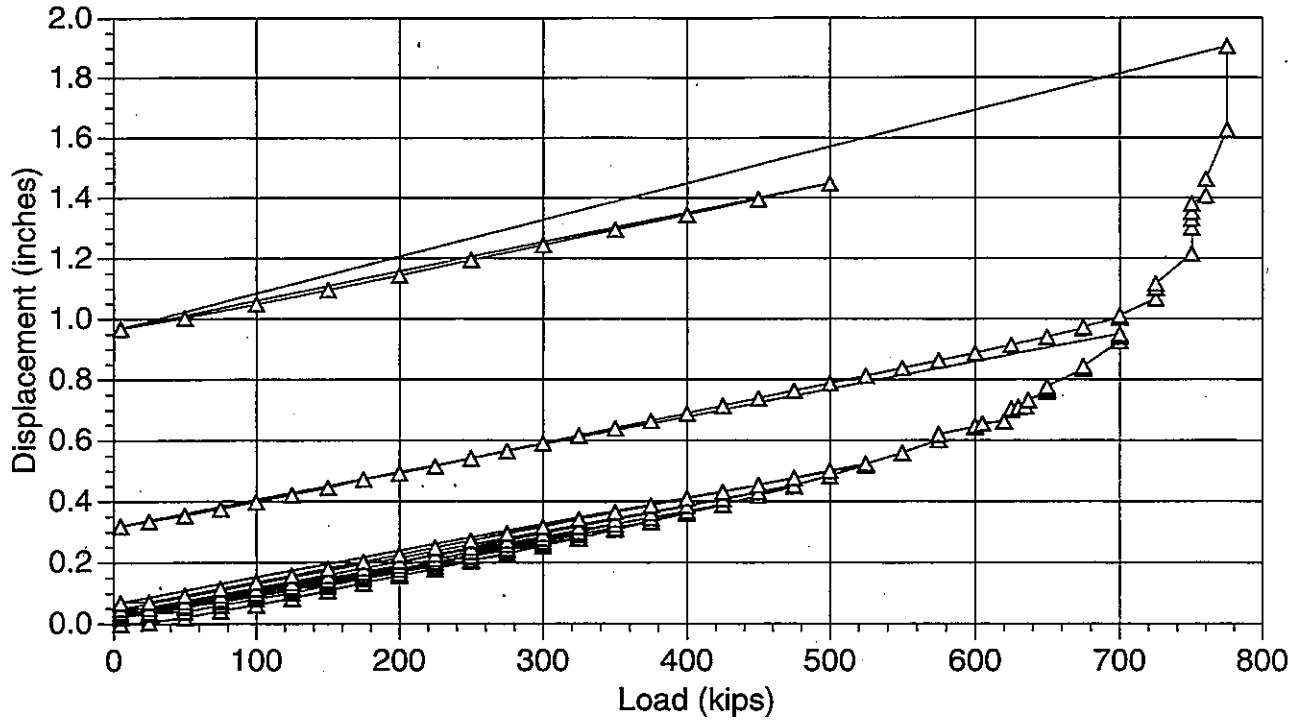
Sample Pile Testing

Note that 5 displacement gauges were used: one each above the lower supports, one each at the two middle loading points, and one at the center of the beam. 4 Strain Gauges were used: 2 at the center, on top of the pile, and 2 at the center, on the bottom of the pile



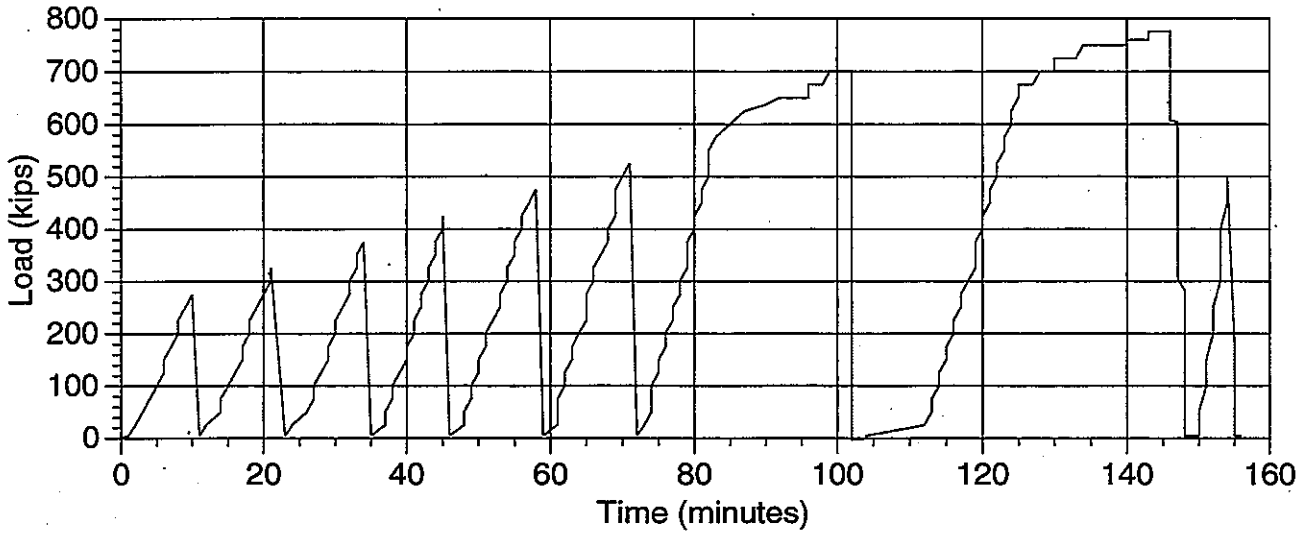
Sample Pile Testing (End View)

The Sample Pile was a concrete filled PP20x0.5, 14 feet in length

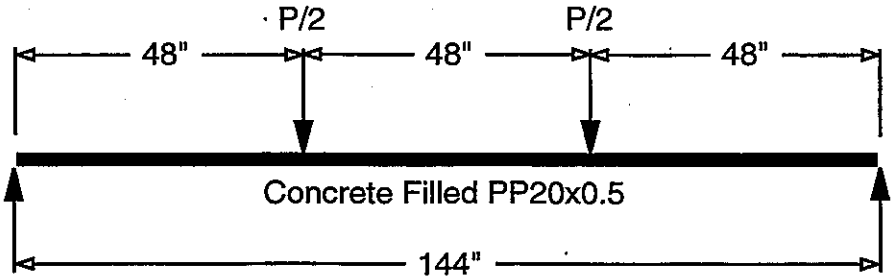


Load verses Displacement

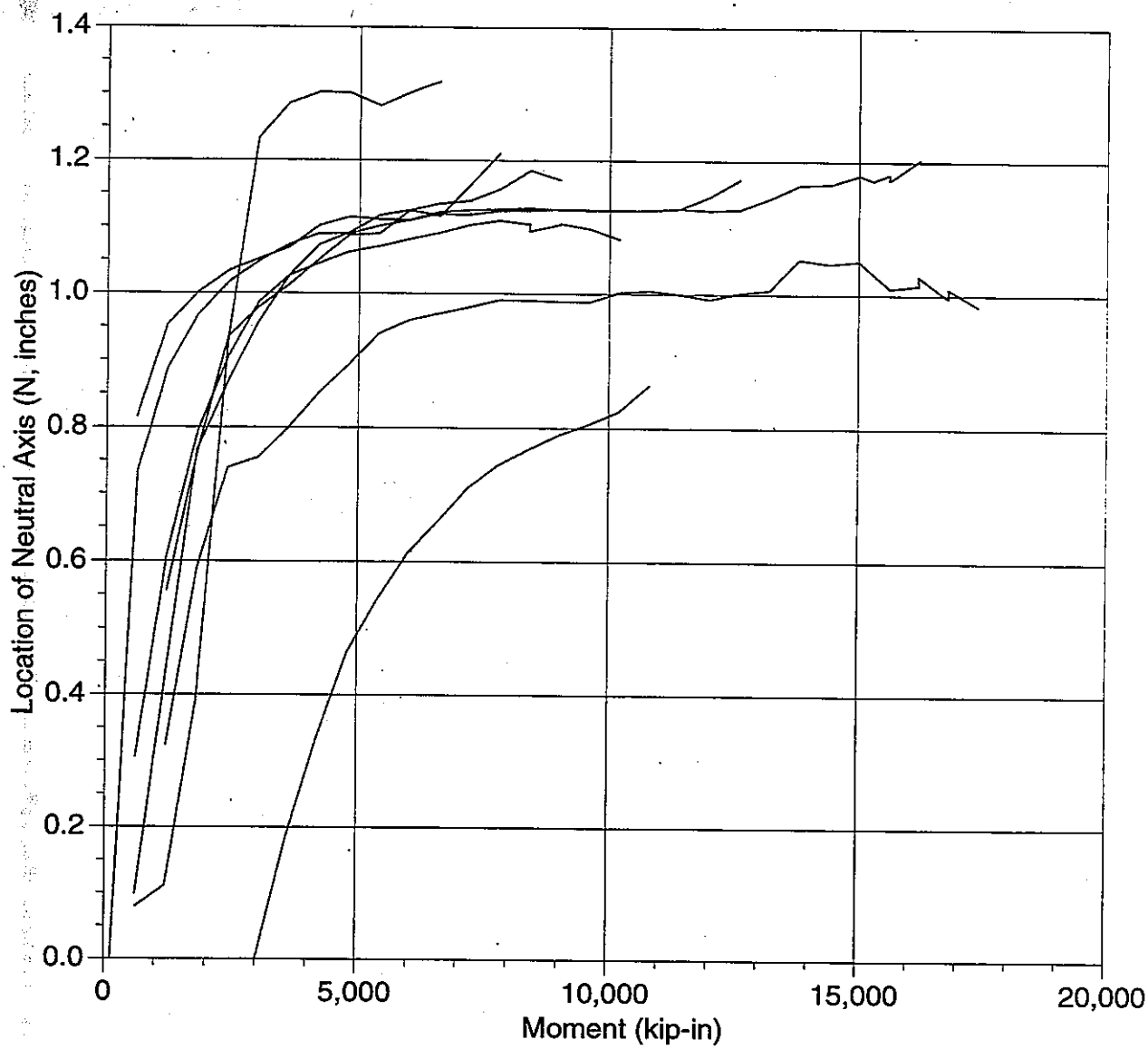
Displacement measurements taken at the center span of the pile



Load verses Time History



Pile Loading Diagram



Neutral Axis verses Moment

Determined from Strain Gauge Data and Applied Load

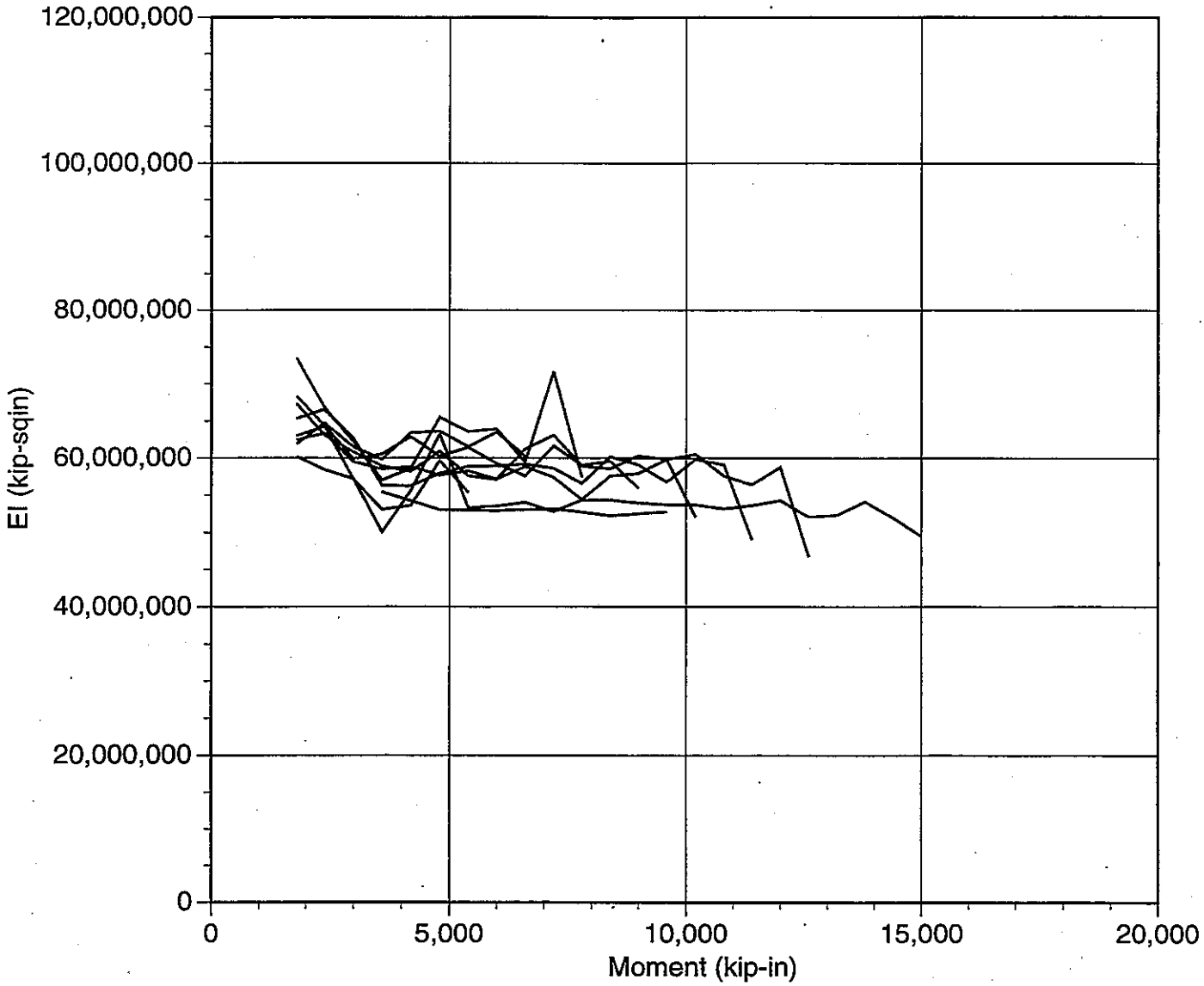
Moment (M) determined as follows:

M=(P/2)(48in) where P=Applied Load

Location of neutral axis (N) is defined as the distance above the geometric centroid of the pile cross section, and is determined as follows:

N=10"-20"Et/(Et-Eb)

Et, Eb=the average strain measured from the top two strain gauges, and bottom two strain gauges, respectively.



Pile Bending Stiffness verses Moment

Determined from Measured Load-Displacement Data

Moment (M) determined as follows:

M=(P/2)(48in) where P=Applied Load

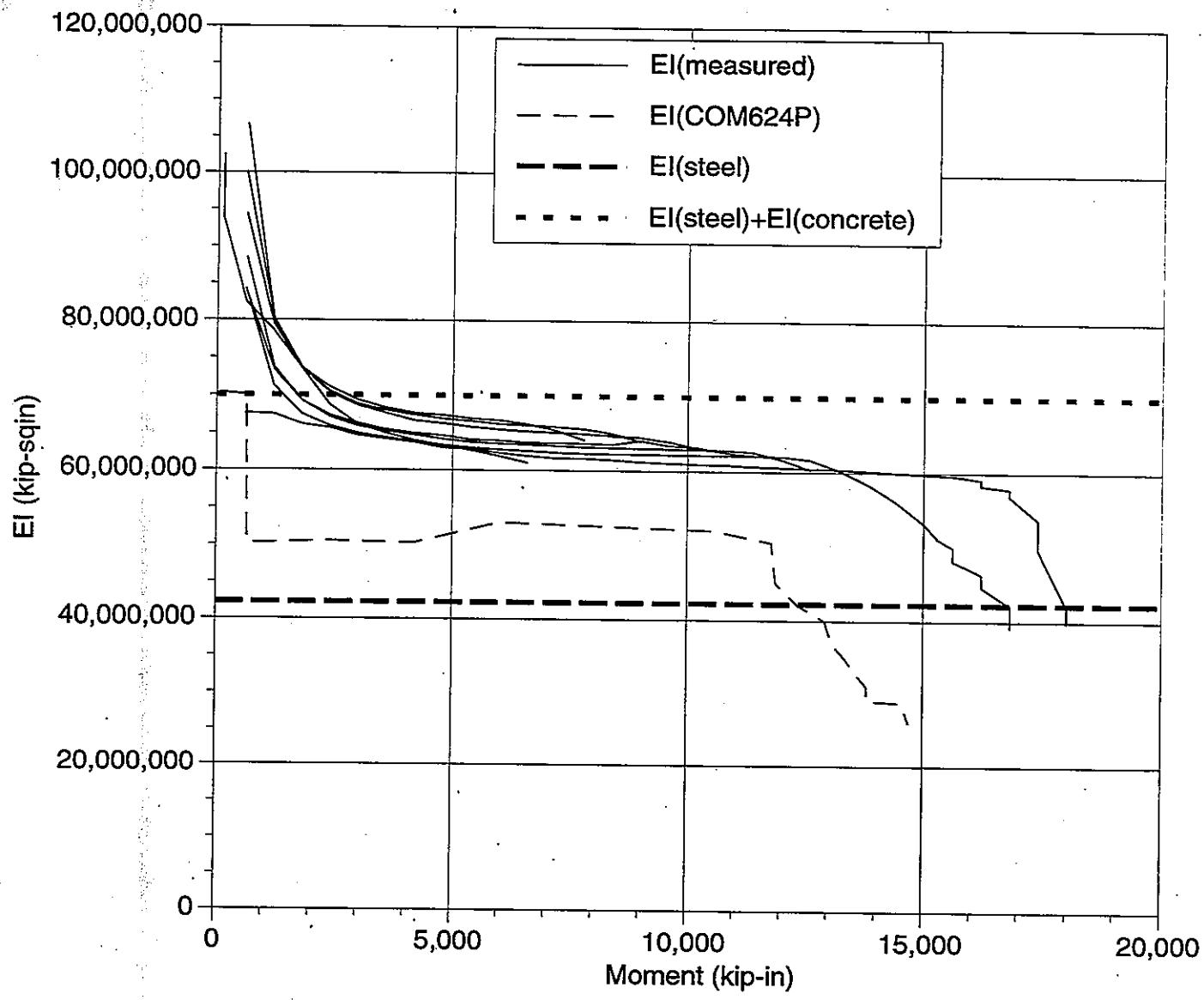
Bending Stiffness (EI) determined as follows:

EI=((P/2)(48")/24d)(3(144"**2)-4(48"**2))

EI=(52,992in**3)(P/d) EI=(52,992in**3)(1/(Δd/ΔP))

Δd/ΔP determined from the measured displacement at the center of the pile (d), and the applied load (P), using a five point central difference as follows:

Δd/ΔP=(di-2-8di-1+8di+1-di+2)/12ΔP



Pile Bending Stiffness verses Moment

Determined from Strain Gauge Data and Applied Load

Moment (M) determined as follows:

M=(P/2)(48in) where P=Applied Load

Bending Stiffness (EI) determined as follows:

EI=M(10in-N)/Et where N=location of the neutral axis

=10"-20"Et/(Et-Eb)

Et, Eb=the average strain measured from the top two strain gauges, and bottom two strain gauges, respectively.

EIsteel=(29,000ksi)(π((20"**4)-(19"**4))/64)

EIconcrete=(4,340ksi)(π(19"**4)/64)

EIcom624p=the bending stiffness verses moment relationship determined using the computer program COM624P for a PP20x0.5 concrete filled pipe pile with f'c=5790psi, and fy=69,000psi